

The Next Moon Race – Robot Division (p. 20)

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The Phantom's Final Mission

How To Fly
An Airliner
From Home

Where Rare
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QF-4 Drone

JANUARY 2009

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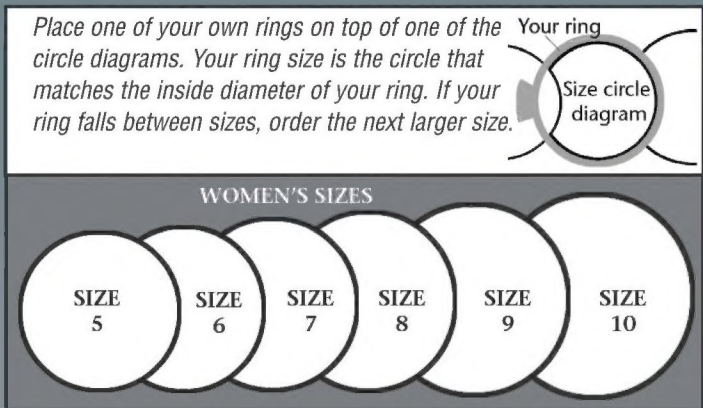
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ON THE COVER: A beater. That's how Chad Slattery described the subject of his signature bird's-eye-view portrait, a QF-4 drone at Mojave Airport, California. U.S. F-4s were still dropping bombs in 1986 (left, over the Bardenas Bombing Range in Spain) and saw action until 1991, before their wingtips got that inglorious splash of orange.



Features

20 Red & the Robots BY GEOFFREY LITTLE
Red Whittaker's robot family is about to get its first little astronaut.

26 NEW SERIES: LEGENDS OF VIETNAM
Where Have All the Phantoms Gone?
BY RALPH WETTERHAHN
Fifty years after the F-4 Phantom's first flight, we mourn the fate of a MiG hunter.

34 Welcome to Cyberspace BY ED REGIS
Love to fly, but fuel costs got you down? Consider this hobby.

40 You've Got Mailplanes
BY JOHN FLEISCHMAN
Antique aircraft fly-ins feel like a simpler time, when airmail pilots were heroes and a stamp cost 3 cents.

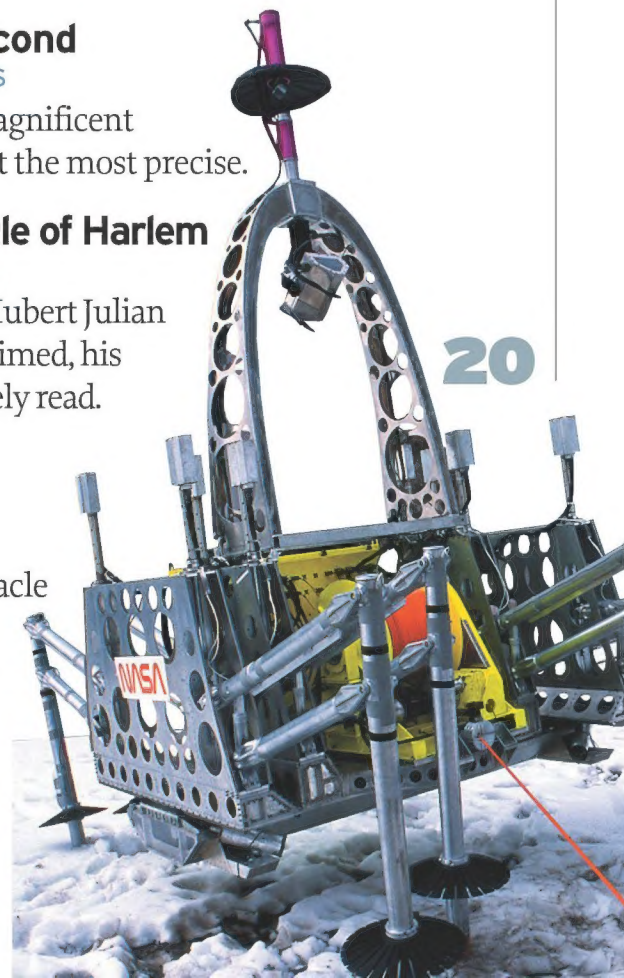
48 How Things Work: Ground Resonance
BY PETER GARRISON ILLUSTRATION BY JOHN MACNEILL
When is a helicopter like a Patsy Cline song? When it falls to pieces.

50 A Cameraman on Mars
BY ANDREW CHAIKIN
Mike Malin's got the photographs. Now all he has to do is figure out what they mean.

56 One More Second
BY JAMES R. CHILES
Why the most magnificent global clock is not the most precise.

58 The Black Eagle of Harlem
BY DAVID SHAFTEL
Whether or not Hubert Julian was all that he claimed, his biography is a lively read.

64 Present at Creation
BY TOM CROUCH
Witnessing a miracle—like the birth of the airplane—is a vision to pass on to your children.



26



40

Departments

- 4 Viewport
- 6 Letters
- 10 Soundings >>
- 14 In the Museum
- 16 Above & Beyond
- 18 Flights & Fancy
- 66 Sightings
- 68 Then & Now
- 70 Reviews & Previews
- 78 Forecast
- 79 Credits
- 80 Moments & Milestones



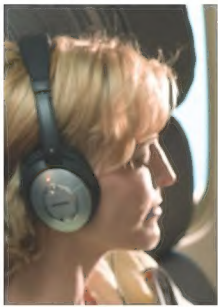
10

On the Web Site www.airspacemag.com

Read about the two Grumman F7F Tigercats that have recently been restored to flying condition (bringing the total in the skies to five), view a photo gallery of the aircraft that have flown as Air Force One, and watch for new blogs, videos, commentaries, and more.

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Amazing Racers

AIRPLANES HAVE BEEN RACING almost as long as they've been flying, and that long history has produced some of the most colorful pilots and honored traditions in aviation—not to mention some really great airplanes. Probably the most famous racing craft in the National Air and Space Museum hangs in the Pioneers of Flight gallery on the second floor of the Museum on the Mall. The Curtiss R3C-2, a dashing black biplane on floats, won the Schneider Trophy seaplane race in 1925, the same year its landplane version won the Pulitzer race trophy. A young Army lieutenant named James Doolittle startled the judges at that seaplane race by attaining an average speed of 232.57 mph. The next day he flew the racer on a straight course to set a world speed record of 245.7 mph.

Remembering that record makes the performance of Jon Sharp's *NemesisNXT* at this year's National Championship Air Races all the more astonishing. Breaking 400 mph in a Sport Class kitplane—at the September 2008 event in Reno, Nevada—was a historic achievement and is the “milestone” in this issue's Moments & Milestones (p. 80). Sharp and his team made history at Reno with an earlier racer, *Nemesis*, which won in the Formula One class (for 100-horsepower homebuilts) for nine years in a row. *Nemesis* is now on display at the Steven F. Udvar-Hazy Center in Virginia.

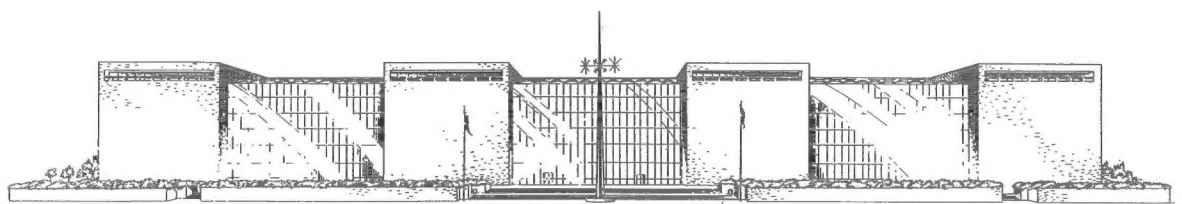
Air racing obviously still attracts talented people and extraordinary airplanes, and this issue of *Air & Space* magazine includes a few other

highlights from the 2008 Reno races. In Sightings (p. 66), you'll see three Grumman F7F Tigercats. One of them competed in the Unlimited category, the only twin-engine aircraft in a field dominated by Mustangs and Sea Furys. The other two were in Reno for a different kind of contest, one that the Museum has participated in for several years. The National Aviation Heritage Invitational encourages the preservation of aviation history by hosting dozens of restored vintage aircraft at the Reno races each year and awarding trophies to the most historically accurate. The trophy, sponsored by Rolls-Royce and engraved with the names of the winners, resides in the Udvar-Hazy Center.

A final item in this issue (p. 11) should make race fans optimistic about the future of what they like to call “the world's fastest motor sport.” Since the late 1980s, Steve Hinton, an exceptional pilot and president of the Planes of Fame Museum in Chino, California, has been the pace/safety pilot at Reno, flying a Lockheed T-33 jet. This year, Hinton's son qualified in the Unlimited class, which his dad won in 1978 and 1985. It looks like racing runs in the blood.

There's no doubt that air racing has fostered aeronautical progress, but what keeps fans coming back year after year, besides the speed and the spectacle, are the personalities. We at the Museum protect and preserve the airplanes, but when we tell their stories, we talk about the people who built and flew them.

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Letters

WRITE TO US

U-2? What U-2?

I always wondered what happened on the U-2 flight recounted in "I Have a Flameout" (Above & Beyond, Aug./Sept. 2008).

In 1967, my dad was manager and chief pilot for Southern Oregon Aviation, at the Klamath Falls Airport. With Seattle Center always on the office radio, he was well aware that a U-2 in distress was preparing to land at adjacent Kingsley Field. When the ground crew later towed the disabled U-2 past, he was standing at the fuel pumps and was able to get a blurry picture (above).

Since Kingsley was a fighter base, it had no tow tractor or bar to manage a U-2, so the aircraft was manhandled to a hangar.

The Air Force refused to admit that a spyplane had landed, of course, but they did send an air cop over to try to confiscate my dad's film. But my father was a former combat MP and the air cop wasn't. You see the results.

Dennis Morehouse
Roseburg, Oregon

Guppy Rising

In the early 1960s I was working as a research engineer for Lockheed Missiles and Space Division at Van Nuys Airport in California, and was able to watch the first Guppy being built directly across the runway ("Big Idea," Aug./Sept. 2008). When I first noticed it—essentially a row of giant hoops—it resembled a huge covered wagon with a wing attached.

Winston C. Adams
Baldwinsville, New York

The Bond Fleet Expands

In *The Man with the Golden Gun*, James Bond flies out to Francisco Scaramanga's island on a Republic



REX MOREHOUSE

The high-tech spyplane gets a low-tech ground assist.

RC-3 Seabee amphibian ("Live and Let Fly," Aug./Sept. 2008). As a boy, I always thought it was cool that Bond could jump into that plane and fly himself out to the island. As an adult, I realize now how bad those movies are.

Matt Shaffer
Castro Valley, California

My sister and I recently watched *Die Another Day*, and she commented that the personal gliders that 007 and Jinx use to get into North Korea were totally "Bond cool" and should have been included in the article.

Scott Wolff
Saugus, California

Editors note: The glider is a Switchblade, designed by Kinetic Aerospace Inc.

That's a Tough Classic

In the early 1950s, my father was the proud owner of a Navion ("Accidental Classic," Oct./Nov. 2008). One cold winter day, he was at 10,000 feet over Monroe, Michigan. One of the propeller blades loosened, and the resulting forces ripped the engine from some, but not all, of the mounts. The force threw the canopy open, and my father ended up having a cold ride. But the airplane was fully controllable, and he said it actually didn't handle too bad! He belly-landed it in a field and walked away without a scratch.

The aircraft was later sold to

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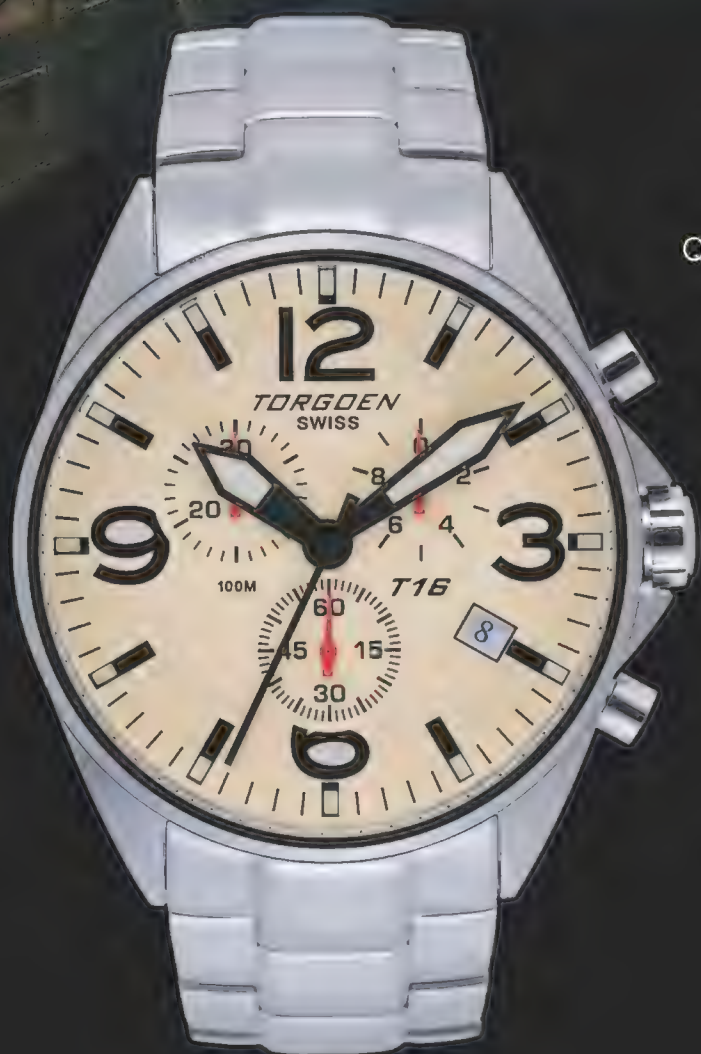
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Letters

someone who had a Navion with a damaged tail section. He was planning to make one aircraft out of the two.

Mark Cryderman
Howell, Michigan

Beaufighter, Medium Rare

"Bobbing for Beaufighters" (Soundings, Oct./Nov. 2008) reports that "only two examples of the type exist today." According to a survey in *Classic Wings* magazine (vol. 15, no. 2), at least 10 Beaufighter airframes survive, two of which are being restored. (Cockpit sections of three more also exist.)

Bill Scrivens
Moorpark, California

Editors reply: We regret the error, which was introduced during editing.

One Winding Paper Trail

"Toy Story" (Oct./Nov. 2008) has a paper airplane cutout with a stamp from Uruguay (and a postage cancellation stamp from New York City). I was born and raised in Uruguay and wonder why the airplane has this particular stamp.

Guillermo Millan
Oceanside, New York

The artist, Orlando Adiao, replies: "I chose that stamp for the winged horse—to continue the 'flight' theme. If I remember correctly, our stock-art resource had only one winged horse stamp, and it was from Uruguay.

"The cancellation stamp—'New York, New York 10003'—was an inside reference to our office location at the time."

Another Angle to Thrust Vectoring

"How Things Work: Thrust Vectoring" (June/July 2008) failed to mention a very important thrust vectoring program conducted from 1970 to 1976 and involving, among others, NASA's Langley Research Center in Virginia, where I was chief of flight operations and chief test pilot. The test airplanes were the Hawker Kestrel and Harrier (modified for the task). Though the vectoring was done by fuselage-mounted rotating nozzles, rather than aft single-exit nozzles, many of the conclusions reached were the same as those reported in your article.

James M. Patton, Jr.
via e-mail

The Belle Took a Beating

"Restoration: The *Memphis Belle*" (Oct./Nov. 2008) did not report that the *Memphis Belle* Memorial Association did at one point restore the famous B-17 and put it on display in Memphis. It was restored when I saw it in the mid-1990s. But the city was not able to raise the funds for a proper building, so the aircraft was displayed in an open structure with only a roof. I read later that the aircraft was vandalized because security was not provided.

Melvin S. Markson
Mt. Prospect, Illinois

Correction

Oct./Nov. 2008 "The Village of Tempelhof," Above & Beyond: The aircraft that landed at Tempelhof in July 1945 was a Fairchild C-82, not C-2.

AIR & SPACE

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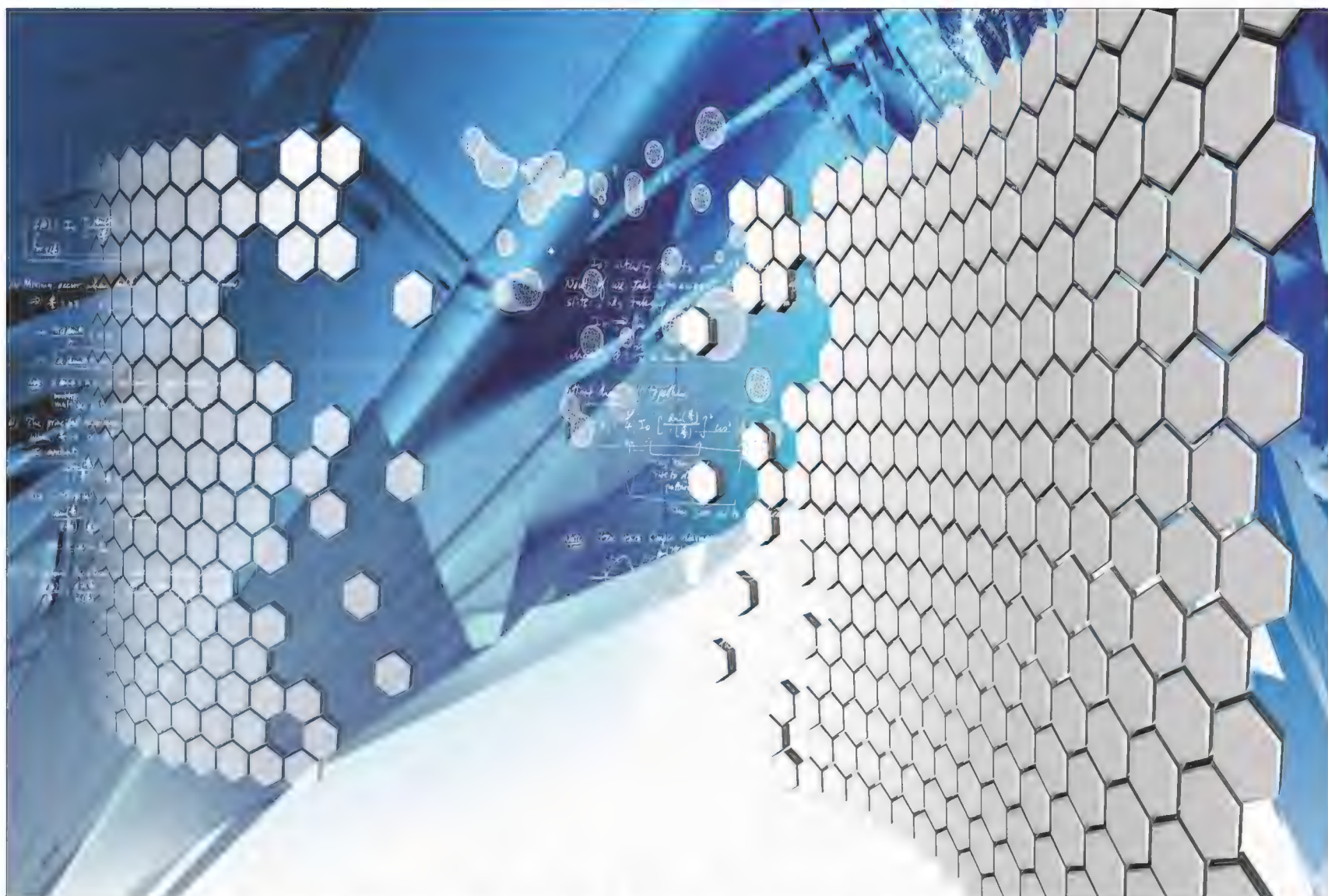
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»» HOW IS A FLY BALL

like an asteroid? The Jet Propulsion Laboratory in Pasadena, California, recently reached out to Major League Baseball to help provide the answer.

On any given day, Donald Yeomans and his team in NASA's Near-Earth Object Program track dozens of objects, some of which could hit Earth years from now. Reporters "jump the gun, imply the Earth will get hit," says Yeomans. "And then, when we come out with orbits refined enough to say for sure, 'Nope, not hitting Earth,' they write that NASA made another mistake or that we changed our minds."

"We're not saying that something *will* hit," he adds. "We're saying we can't rule it out until we get a good handle on the orbits,"

"Outfielders understand trajectory, parabolas, 'guestimating' locations, and how time is the only way to narrow down where the ball will land."

which can take months or even years. "They forget to report that part. I guess obliteration makes a better story."

So, to better inform the



public, as well as those news anchors who forecast imminent doom, "we filmed a video with Matt Kemp, one of the great hitting outfielders for the [Los Angeles] Dodgers," says JPL spokesman D.C. Agle. "Outfielders understand trajectory, parabolas, 'guestimating' locations, and how time is the only way to narrow down where the ball will or won't land."

"When the bat first cracks the ball," says Yeomans, "the outfielder can't rule out that it might hit, say, right in front of him. A second or two later, the ball keeps moving. The information keeps



changing. He adjusts his position. He keeps gauging and refining where he thinks the ball will or won't go."

Kemp really got into the spirit of things, Yeomans says. "Matt even joked that

NASA's Near-Earth Object Program manager Don Yeomans tells Dodger outfielder Matt Kemp what fly balls and asteroids have in common.

we each deal with the sun's rays getting in our way."

Yeomans says he dreads the day the mainstream media get wind of an asteroid named Apophis. If—and this is a very big if—Apophis passes through a narrow keyhole in 2029, it would hit Earth seven years later. "Easter Sunday 2036 to be exact," says Yeomans. Unless somebody invents a pretty good spacefaring outfielder.

   HOLLY HICKMAN

Chino Kid 2.0

»» **WHEN HE SHOWED** up at the Reno Air Races' Pylon Racing School last June, Steven Hinton, at 21, became the youngest pilot to qualify for the event's Unlimited class. This was especially big news at the races last September because racing fans all know Hinton's dad, Steve.

When Steve Hinton burst onto the air racing scene in 1975, he was already well known. He was one of "the Chino Kids," a group of young pilots who performed at airshows in the warbirds of the Planes of Fame Air Museum, run by Ed Maloney at California's Chino Airport (see "Ed Maloney's Mission," Feb./Mar. 2008). Hinton grew up working on the airplanes, absorbing the culture, and learning the skills he would use for a lifetime of flying and



preserving rare and demanding warbirds. In 1978, Hinton, then 26, became the youngest pilot to win the Reno Air Races Unlimited class championship. By the time he retired from racing, in 1990, he had won two gold Unlimited championships, wrested the absolute world speed record for propeller-

driven aircraft from the legendary Darryl Greenamyer, and survived a horrific crash at Reno in an RB-51 Mustang. These days, Steve Hinton, flying a Lockheed T-33 jet, is the pace/safety pilot for the Unlimited class.

An air race pilot is made, not born, says Karen Hinton, Steve's wife and the

Steven Hinton, air racer on the fast track, made his debut at the 2008 Reno Air Races.

mother of their son, Steven, a second-generation Chino Kid. "Because his dad was Steve Hinton, he became aware of air racing, but other than that, it was all his own doing," she says. By the time the younger Hinton entered his first race, he had 800 hours of flying time, much of it in Stearmans, North American AT-6 trainers, and a P-51. He had worked on the crew of the highly modified P-51 *Strega*, including an engine change in the middle of the night for a next-day race.

In September, when the time came to race, the elder Hinton merely advised his son, "Make sure your head's up"—pay attention to the overall situation.

By Sunday, though, the father-son team was working closer together. Steven had raced his way up to the pole position, which meant he would be flying

UPDATE

Air America

The Glenn H. Curtiss Museum's *America* reproduction, which debuted in 2007 but, underpowered, couldn't take off ("America the Cruisable," Feb./Mar. 2008), made its inaugural flight at last September's Seaplane Homecoming in upstate New York. Pilot Jim Poel, a retired American Airlines captain, and copilot Lee Sackett lifted off from Keuka Lake and splashed down gently before an audience of 2,000 14 minutes later. "As I started downwind, I could feel the step, that point when the aircraft separates from the water," Poel says. "The *America* lifted off beautifully. Taking her on the turn around the lake was terrific. She handled magnificently."



Liftoff for the Curtiss *America* reproduction.

FRANK McNALLY

Soundings

on his father's wing. "I wanted to get into position smoothly, stay there, and take the workload off of Dad, so he could pay attention to the rest of the flight."

Flying at 314.111 mph, Steven Hinton took third place in the 2008 Sunday Bronze. When it was over, he got a call on the radio. "Race 44, Pace is coming up on your right wing." Steve Hinton's T-33 slid into formation, and the lead/wingman roles established at the beginning of the race were reversed. "His visor was down and the oxygen mask was on, but I could see from his face that he was smiling," said Hinton the younger of Hinton the elder.

As for Karen Hinton, watching her son's first air race season? "I was thrilled for him," she says. "Terrified, but thrilled for him."

LARRY LOWE



UPDATE

All Ship-Shape

FRESH OUT OF REBUILD, the aircraft-carrier-turned-museum *Intrepid* was towed from Staten Island up New York Harbor and the Hudson River to its home at Pier 86 on a sunny day early last October ("Restoration: Cleaning a Carrier," Aug./Sept. 2008). Four tugboats hauled the carrier some five miles, accompanied by a veritable battle group of police boats and sightseers. Some 200 *Intrepid* crew members were on board for the vessel's last sail. On the flight deck were 24 aircraft, many freshly repainted; five were new additions to the carrier's exhibits. A grand re-opening was held on Veterans Day, November 11; the *Intrepid* Sea, Air, & Space Museum draws 75,000 visitors a year.

Tug-of-Warbird

"KEEP 'EM FLYING" has been the Commemorative Air Force's motto since it

was formed in 1957. And it does just that, getting wealthy sponsors to fund upkeep of its World War II

aircraft, 160 all told, which fly at airshows across the country.

In 1986 the CAF's F-82 Twin Mustang—the only one flying—made a rough landing that damaged the landing gear and propellers. No sponsor stepped forward to fund the needed repairs. Fifteen years later the CAF engineered a trade: The wrecked F-82 and an un-airworthy P-38 to one Jim Fry in exchange for his flyable P-38. Just one small problem. The U.S. Air Force Museum heard about the swap, and told the CAF that the Twin Mustang wasn't theirs to trade. The Air Force wanted it back.

Designed late in World War II for the planned invasion of Japan, the Twin Mustang was the response to a call for a fighter with a range long

UPDATE

Private Harrier Goes Public

Art Nalls' FA2 Sea Harrier ("Howling Soon at an Airshow Near You," Soundings, Apr./May 2006) made its first public flight at the Culpeper Air Fest in Virginia last October for an enthusiastic crowd of 4,000, the biggest turnout in the airshow's nine-year history. Nalls acquired the vertical-landing-and-takeoff superstar from the Royal Air Force in 2006 for about \$1.5 million, and has spent the last two years preparing it for the airshow circuit. The effort suffered a setback when an inflight hydraulic failure required Nalls to execute an emergency vertical landing at the Patuxent River Naval Air Station in Maryland a year ago. Nalls finessed the hover and landing, but the landing gear collapsed, adding 10 months to the prep schedule.



The privately owned Harrier debuted to a roaring crowd.

enough to escort B-29s across vast stretches of the Pacific. The war ended before the Twin Mustang could enter sustained production, but during the Korean War it served as a night fighter.

North American built some 170 Twin Mustangs and variants. In 1966 the CAF went looking for one, but by then all but five had been scrapped, and none of those was flyable. One was at the National Museum of the U.S. Air Force in Dayton, Ohio, and two were guarding a gate at Lackland Air Force Base in Texas. The CAF persuaded the Air Force to donate one of them.

Air Force policy says it still owns most of the airplanes it ever built, including the CAF Twin Mustang. And before anything can be sold or given to an individual or museum, it has to be rendered unflyable.

The CAF refused to hand over the fighter, so the Air Force sued the CAF: last July a federal court ruled for the Air Force. The CAF filed an appeal. "Our fear, and rightfully so, is that they would make the airplane unflyable," says Stephan Brown, CAF president. "That would render our whole exercise moot."

To be prudent, says Brown, the CAF backed out of the deal with Jim Fry, and has stored the F-82 in its hangar. Recently a sponsor promised to pay for its restoration, and to keep it flying, should the CAF win its appeal. "Ours is certainly going to take some work," Brown says.

PHIL SCOTT

John H. Hill

CURATOR-IN-CHARGE OF AVIATION, SAN FRANCISCO AIRPORT MUSEUMS

Through January 2009, the San Francisco Airport Museums is featuring an exhibit on how airliner seating has evolved. On display are seats from a Ford Tri-motor, Fokker F-10, Boeing 80A, 247, 727, and 747, Douglas DC-3 and -4, and Lockheed Constellation.



John Hill's exhibit shows how airplane seating evolved from "scaled-down porch furniture."

What does the exhibit demonstrate?

What flying was like in the formative years of the airlines: that the airplane was once predominantly a communications tool where emphasis was placed on the airmail, that slowly this new form of transportation became more commonplace. And that arc can be plainly seen in the historical sequence of objects such as airline passenger seats. Today, air travel is so commonplace to such a large segment of the public that it has become something of an entitlement. But it wasn't too long ago that aviation was very small, very novel, very expensive, very dangerous, and not very fast, [compared to] rail.

How did you acquire historic airline seats?

The Ypsilanti wicker is one of a pair we acquired from a source in southern Florida in 2001, and their provenance traces back to the daughter of a man who was with Pan American Airways in the late 1920s and '30s. The American Airlines C.R. Smith Museum at Dallas-Forth Worth Airport loaned us the DC-3 seat. The circa-1958 Teco seat was donated by the Save A Connie group in Kansas City, Missouri, now the Airline History Museum.

What is the predominant theme in the evolution of passenger seating?

Historically, the comfort of the seats [and] the duration of the flights are in inverse proportions. In other words, early seats, say, on a tri-motor of the late 1920s, were fairly rudimentary, with passenger service being something of an afterthought compared to mail and express. But a flight from San Francisco to Los Angeles could take three and a half hours.... Compare that with today's 55-minute flight time [but] with relatively comfortable seats even in economy [class]. You can see the trend in each succession of seat design as comfort became a competitive element. This really ramped up post-World War II. [Seating evolved] from scaled-down porch furniture at a cost of way less than \$100 per unit to dazzlingly sophisticated sitting/reclining/sleeping machines that can approach \$200,000 each.

What about aesthetics?

The Alcoa seat has a wonderful Machine Age look. The tubing and corner braces evoke the aluminum framework of an airship.

With the DC-3 seat, the aluminum frame is hidden and the sides are covered with synthetic panels whose shell-like patterns hint at Art Deco.

The 1993 Weber first-class seat's aesthetic appeal is more closely tied to tactile stimuli. The controls and personal electronics put the passenger in a seat that functions as a mechanical exoskeleton, physically adjusting your position while serving as a bedroom, dining room, office, and entertainment center all rolled into one. No longer static furniture, the airline passenger seat has become a system designed to anticipate a nearly limitless range of human factors and cultural needs.

In the Museum

STOPS ON A TOUR THROUGH AMERICA'S HANGAR

The Secretary's First Impressions

ON A RECENT VISIT to the National Air and Space Museum, new Smithsonian Secretary G. Wayne Clough called his first few months at the institution a “whirlwind.” Clough, a civil engineer, came to Washington, D.C., last July to begin his tenure as the Smithsonian Institution's 12th Secretary. For the past 14 years, he had been president of the Georgia Institute of Technology in Atlanta.

“The Smithsonian has so many moving parts,” said Clough. “I’ve made 25 visits to different parts of the Smithsonian and had a chance to see the people who make it work. And everywhere you go there’s always some surprise.” One of those surprises, Clough said, was learning of the impact the Museum’s Center for Earth and Planetary Studies (CEPS) is having on the travels of the NASA rovers *Spirit* and *Opportunity*, now in their fifth year of rolling around Mars.

Accompanied by NASM director Jack Dailey, Clough observed images from both rovers that had just come in from NASA’s Jet Propulsion Laboratory in California. As one of the leaders of the group directing the rovers’ mission, CEPS chairman John Grant has participated in selecting many of the sites the rovers have investigated, and receives data from JPL daily.

Clough and Dailey also paid a visit to the Museum’s Paul E. Garber Preservation, Restoration and Storage Facility in Maryland. Restorers there are readying air- and spacecraft for display at the Steven F. Udvar-Hazy Center in nearby Virginia.

“We keep getting more artifacts and less space,” remarked Dailey, “and even though we still have quite a bit of room out there [at Udvar-Hazy], when we complete the transfer, we’ll have airplanes and spacecraft remaining. Our plan is to make them available for

loans to other museums. None of us can adequately display all that’s available, but we are partnered with museums throughout the country, and cooperatively we can get these treasures on view for people to see.”

Dailey also pointed out that it’s not just the artifacts that are being moved to the Udvar-Hazy Center; the restoration work itself will be done there. For years, seeing the restorers at work had been a favorite reason for aviation fans to visit the Garber facility, but that space couldn’t accommodate as many people as walk through the museums. When a new restoration hangar is constructed at the Udvar-Hazy Center, all visitors will have the opportunity to watch craftspeople and restorers take apart the Museum’s famous machines and put them back together again.

“But I’m gonna make a bet with you,” said Clough, “that some things will still be out at Garber after all is said and done. You need a kind of boneyard with an operation like this.”

Like the construction of the first phase of the Udvar-Hazy Center, the new \$74 million hangar, which will also include space for Museum archives and a conservation laboratory, is to be privately funded. Work began in October. The \$311 million Steven F. Udvar-Hazy Center, which opened in December 2003, was the largest construction project the Smithsonian had ever undertaken, and the first one funded entirely by private contributions. Those two construction projects and others at the Smithsonian depend on philanthropy, Clough

On a tour of the National Air and Space Museum, Secretary Wayne Clough (at left) and Director Jack Dailey pause in a gallery showcasing the Wright Flyer.



ARTIFACTS

Homemade Revolution

POWERED BY A MODIFIED Volkswagen engine, Burt Rutan's VariEze first flew in May 1975; its appearance three months later at that year's Oshkosh, Wisconsin fly-in sparked a revolution. Homebuilders embraced the VariEze's canard configuration and simple construction, eventually buying more than 3,000 sets of plans. The VariEze in the National Air and Space Museum's collections – N4EZ – was the second built by Rutan and his team. In 1977, NASA aerodynamics experts, interested in the



While the VariEze looked exotic, the airplane was mechanically simple and easy to build – by 1980, some 200 were flying.

spin resistance of the aircraft, spent several days flying N4EZ at Rutan's shop and eventually persuaded their agency to build two for flight test and

wind tunnel research. N4EZ was flown from Rutan's base at the Mojave Airport in California to the Museum in Washington, D.C., in 1986.

DANE PENLAND

noted, but there is also a critical role for the government to play.

"Jack has been a wonderful fundraiser for new construction," Clough said. "It's tougher to support basic maintenance. That's the job of the federal government.

"One of the things that surprised me is something everybody else around here takes for granted," he continued. "It's the fact that these museums are open every day of the year but Christmas. And you have 24 million people tromping around through these buildings, and that is taking a toll on them. Universities have a toll as well, but we close down for periods between semesters specifically so we can get the buildings back in shape. We don't have that kind of luxury here. So because we are serving the American people in significant ways, the government has an obligation to support that mission."

After his stop at the National Air and Space Museum, the new Secretary was headed to a meeting to establish a strategy for the many Smithsonian Institution Web sites. "We need to bring young people into these museums in a much bigger way than we've done in the past," he said. "Some of that we'll do with the Web."

Still, at the Udvar-Hazy Center, he

couldn't help noticing that a lot of high school kids were working as docents and helping to teach other students about the collection. "I think that's really important," he said. "A lot of the visitors to our museums are youngsters and they relate to youngsters."

One of the surprises Clough encountered during his travels around the Smithsonian was at the Udvar-

Hazy Center, where he tried his hand at the Wright Model B simulator. He found out that the Model B was a lot harder to fly than it looks; his performance, he said, was not impressive. And another surprise: As he struggled with the controls, the person giving instructions to the one-time university president was a high school student.

LINDA SHINER

Visitor Information



Docent Tours Docent-led tours highlight the Museum's collection and trace the history of air and space travel. Tours are conducted daily at 10:30 a.m. and 1 p.m. At the National Air and Space Museum on the Mall, meet at the Welcome Center. At the Steven F. Udvar-Hazy Center, meet at the docent tours desk in the Boeing Aviation Hangar.



What's Up Receive regular updates on Museum events, read about artifacts, get detailed (and behind-the-scenes) exhibition information, and receive calendar listings, all by subscribing to the National Air and Space Museum's free monthly e-newsletter, *What's Up*. Sign up at www.nasm.si.edu.



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Above & Beyond

MEMORABLE FLIGHTS AND OTHER ADVENTURES

Take a Left at Portugal

OPERATION EL DORADO CANYON, the 1986 U.S. bombing raid against Libya, began for me with a phone call at noon on Sunday, April 13. I was a U.S. fighter pilot flying General Dynamics F-111F Aardvarks out of Royal Air Force Lakenheath in Britain. The caller told me to report with my flying gear to the 494th Tactical Fighter Squadron, which was odd, since I was assigned to the 495th. Flying out of a rival's squadron could be like a bad date, with both parties hoping never to see each other again.

I arrived around 1 p.m. The pilots were assembled in the main conference room and briefed. For the first time since World War II, U.S. aircraft were going to launch on a strike mission from England.

Although the wing had been involved in planning various attacks against Libya since January in retaliation for Libya's support of international terrorism, strike plans had been limited to four to six aircraft and a single target. Now, with 24 hours until takeoff, the Air Force plan had expanded to 18 F-111Fs aimed at three targets. (Off Tunisia, we would join forces with Navy aircraft operating from carriers in the Gulf of Sidra, which would also attack Benghazi, on the eastern side of the Gulf.) Three F-111s were to strike a terrorist training facility at Murat Sidi Bilal, six were assigned the military ramp at Tripoli airport, and nine of us (I was to be number 3 in this group) were going against the Bab al-Aziziyah Barracks in downtown Tripoli. France and Spain were not likely to grant us overfly rights, and there was a problem amassing enough tankers to keep us fueled for the longer flight.

I was probably the most junior pilot chosen for the mission. I had never



Because France and Spain would not grant the United States overfly rights, the 1986 F-111 raid on Libya required a lengthy detour.

flown below 400 feet at night; our mission called for a run to the target at 200 feet—and 700 mph. I had never dropped live ordnance; my jet was armed with four 2,000-pound laser-guided bombs. My previous longest mission had been 4.5 hours; the planned route around Spain and back would take more than 13. Moreover, I had never air-refueled from a KC-10 tanker, air-refueled under radio silence, or ejected chaff or flares (countermeasures to foil radar-guided and heat-seeking missiles).

Fortunately, I was paired with an experienced weapon systems operator. Mike and I stayed up late planning, then crashed in the base transient

quarters, returning the next day, Monday, to the 494th, where we received the latest intelligence estimates, finalized the air refueling plan, got amphetamines from the flight doc, signed for our sidearms, checked out classified codes, and grabbed box lunches. I also grabbed plenty of piddle packs.

After the final briefing, we boarded crew vans. I sat next to the mission commander and confessed, “Boss, I’ve never refueled from a KC-10 before.” He looked at me like Ward Cleaver would at the Beaver. “Now’s not the time, Jim. You’ll do fine.”

Takeoff and rejoin went smoothly, and our armada turned south, flying along the Spanish and Portuguese coasts. Just as the sun was setting, I watched as six KC-10 tankers each took on fuel from six other KC-10s, which had just been refueled by six

KC-135s. Next to each of the KC-10s gassing up, three F-111Fs waited their turn. Flying south amid this spectacle, I hummed Wagner's "Ride of the Valkyries."

After my 10th refueling, I disconnected from the boom, turned off our lights, and initiated a terrain-following radar descent. At 5,000 feet, we discovered a malfunction in the radar altimeter, a crucial instrument when flying over smooth terrain like water. I leveled off when the altimeter read 1,000 feet—based on the barometric pressure forecast we received before takeoff.

Our last radar update point before the Libyan coast was a tower on the western tip of Italy's Lampedusa Island. Our navigation system had been running sweet, but when Mike selected the tower, the cursors fell about one mile to the west. An error during the planning process had resulted in incorrect coordinates being issued to all crews. Mike recognized the error and did not use the coordinates to update our navigation system. His decision was probably the single greatest factor enabling us to hit our target: those who updated their nav systems based on the bad coordinates missed. What I remember most about the tower is that we passed well beneath its top. Just how high were we above the waves?

Between deep breaths, I fretted about a possible recall. What if we were the only airplane not to get the word? Then, as we approached the target, all hell broke loose.

The sky was overcast, and the moon had set about four hours earlier. We had flown the entire route "comm out;" our last weather brief, before takeoff, had forecast a 20-mph tailwind from Lampedusa to the target, but instead we were fighting a 23-mph headwind. If the winds were this off, maybe our forecast altimeter setting was just as wrong.

Without afterburner, the airplane's max speed was 655 mph. Approaching the starting point for the bomb run, we were 10 seconds slow, so I selected afterburner to accelerate to 690 mph

for two minutes. The airplane jumped at the chance to go faster, and I had to fight off vertigo to keep it level. When we hit the start point, I turned left toward the target, hacked my stopwatch, and again selected afterburner. Our target run was planned for 690 mph at 200 feet. We didn't dare descend, but we had to nail the timing or we'd risk hitting someone else's airplane or bombs.

The target run was a sensory overload. The terrain-following radars gave off an incessant, blaring "fly up" alarm. Even though we did not have them engaged, we didn't dare turn them off, since the radar scope was picking up a faint return from the waves. On top of that noise, the radar warning receiver was sounding a constant "New-Guy Audio." The audio was to warn us of a new priority radar threat. The Libyans were turning their search radars off and on and using their beamed tracking radars to search for us. Each search radar cycle or sweep of the target trackers triggered our radar warning. The end effect was like a broken record. I would have punched off the audio but was afraid I'd accidentally punch off something important, like the intercom or radio.

As we approached Tripoli, the sky was filled with tracers and surface-to-air missiles, but the real threat was of

At the pull-up point, I initiated a 4-G pull, concentrated on centering the steering, pressed the bomb release button (the "pickle"), and let the armament system compute when to drop the bombs. I relied on my training and acted on reflex. Chaff, pull, pickle, chaff. "Bombs gone." Chaff/flare, wingover. "18 seconds to impact." Chaff/flare. "10 seconds." Chaff/flare. "5 seconds." Chaff/flare. "Impact." Chaff/flare.

Just after our bombs hit, I saw a large, napalm-like explosion across the harbor. It had to have been Karma 52, the F-111 that was lost on the raid. Neither of us could afford to dwell on our feelings; there was still too much flying to do. With the bombs gone, I swept the wings back and got out of Dodge as fast as possible without using the afterburner, since it had proven to be an anti-aircraft-artillery magnet.

About 90 minutes later, we latched onto the boom of a tanker with 2,000 pounds of fuel—about 15 minutes of flying time—remaining. We landed at Lakenheath and were towed into a shelter, where a caravan of cars pulled up. General Charles Gabriel, the Air Force chief of staff, was eager to welcome us back. I put my helmet in its bag and started gathering my other stuff: pistol and ammunition, maps, code books, checklists, an empty lunch

Just after our bombs hit, I saw a large, napalm-like explosion across the harbor. It had to have been Karma 52, the F-111 that was lost on the raid. Neither of us could afford to dwell on our feelings; there was still too much flying to do.

plunging into the water. With our unreliable altimeter setting and no radar altimeter, we didn't know how high we really were, and at 700 mph, it wouldn't have taken much of a distraction for us to smack the waves.

We arrived at our pull-up point, with 18 seconds to go to the target. Our tactic was to "toss" the bombs, do a wingover, and then remain at altitude to laser-guide the bombs. Just prior to pull-up, I de-selected the afterburner and reset the wing sweep to 54 degrees.

box, water bottles, and two full piddle packs. I carefully rose from the seat and descended the ladder. As soon as I turned around, there was General Gabriel, his right hand extended.

Our eyes met. It was an awkward moment for me, but the general instantly understood. He immediately took the piddle packs with his left hand, while shaking my now-free right. The first time I met the chief of staff, I gave him two pints of urine.

 JAMES A. JIMENEZ

Flights & Fancy

WHIMSY, NOSTALGIA, AND JUST PLAIN MISCHIEF

A Christmas Story

IN THE EARLY 1970s I was copilot on a 4th Military Airlift Squadron Air Force C-141 jet transport at Yokota Air Base, near Tokyo. One winter we spent two weeks shuttling people and cargo all over Japan, South Korea, and southeast Asia, and when the work was done, we really wanted to get home for Christmas. But unless we could be assigned to an aircraft heading east to Seattle, that was not going to happen.

Then, good news: The day before Christmas, a mission was going east, to Norton Air Force Base in San Bernardino, California. It was leaving at 10 p.m., so we'd miss Christmas Eve, but by crossing the international dateline, we would be home on Christmas Day to deliver the goodies we had bought in Japan—if we could hitch a ride from Norton to Seattle.

As we headed for the airplane, we passed through an empty terminal, where we spotted a seven-foot, fully decorated, live Christmas tree. "Wouldn't that look great in the cargo bay," I thought. "We could linger at the tree with our coffee and look forward to playing Santa Claus." While the loadmaster made final checks of cargo placement, I found a spot for the tree, with its garlands of fake holly and strands of gold and silver balls.

While refueling at Elmendorf Air Force Base at Anchorage, Alaska, we went through U.S. Customs and Immigration, where officials checked our passports and sent us on our way. The cargo got a permit to proceed—it could legally be flown to another point, where it would be inspected by a Customs agent.

We passed over a snoozing Seattle around 6 a.m. Somewhere over



northern California came the first hint of a problem. "Uh, Pilot, this is Load. Do you have the cargo manifest and the Customs papers?"

"Load, Pilot. No, why would I have them?"

"Copilot, Load. Do you have them?"

"Load, Copilot. You have them somewhere back there."

"I've looked everywhere."

Landing without the paperwork could be a serious matter. We could be accused of smuggling—bringing in cargo with no proof of having passed it through Customs.

Finally, we figured that we must have left the paperwork somewhere at Elmendorf. We made a call, and sure enough, the papers were on a clipboard on a counter.

We compromised with the agencies involved. We could continue to San Bernardino, where we would be met by all concerned and allowed to leave because we had cleared Customs in Alaska. The aircraft would be

impounded with cargo on board awaiting the paperwork, and Agriculture would make a new inspection. And we learned there was a flight north that would wait for us for an hour.

The mountains northeast of Los Angeles hove into view. The air was bumpy, as it often was coming across the foothills. And it was not unusual for one of the two passenger doors to get bumped out of its fully locked position. So when the "Door Open" light went on, we weren't too surprised. "Load, Pilot. Can you check doors please?"

"I'm on it." And after a minute: "How's that?"

"Light's off, thanks."

Gear down, cleared to land, back on the ground.

Taxiing in, however, brought an unpleasant realization. We had to undergo another Agriculture inspection, and they were serious about not bringing foreign plants into California. And here we were with a live Christmas tree. By the time we explained and had the airplane fumigated and who knows what else, our ride north would be long gone.

As we discussed the situation, the loadmaster chimed in. "Pilot, Load. I wouldn't worry too much about the Christmas tree. Remember that 'Door Open' light 10 minutes ago?"

Somewhere on the West Coast, a woman in her mid-30s is telling her daughter, "Yes, there is a Santa Claus. I remember the Christmas Day when I was a little girl in California and we didn't have a tree. And then, out of the sky, a fully decorated Christmas tree landed in the yard. It could only have come from Santa."

CHRISTOPHER HOPE

DAVID CLARK

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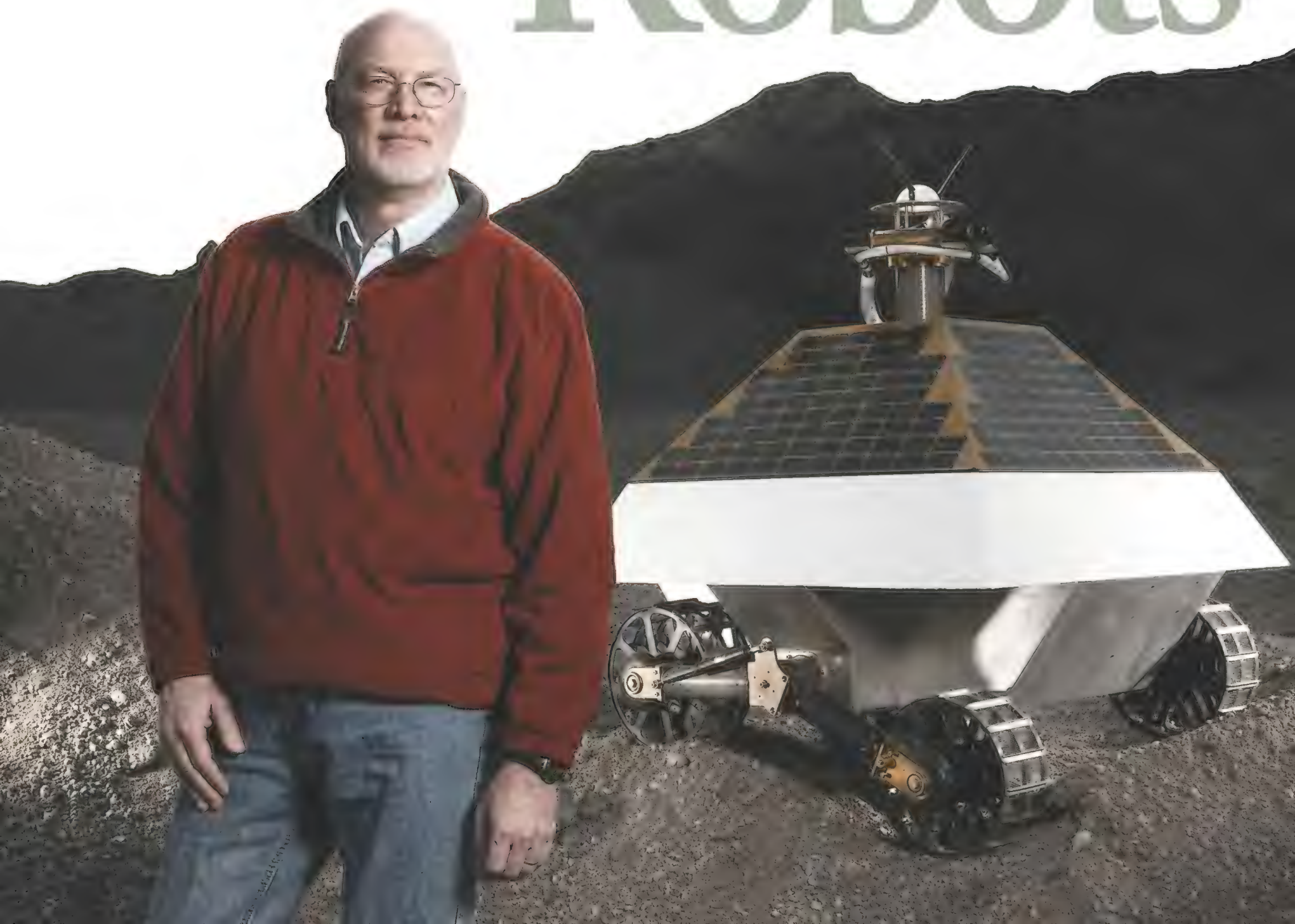
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Red & the Robots



THE SCRAPING OF METAL WHEELS on loose rocks and the clicking sounds of mechanical actuators alert me to the lunar rover's presence before I see it. Turning, I come face to face with the robot as it emerges from a shallow ditch, its two mast-mounted camera "eyes" gazing at the ground, then tilting up to scout a way forward.

Less than five feet tall and three feet across, it's an unassuming 'bot: a truncated pyramid plastered with solar panels, moving on four wheels tucked underneath. As it passes me, the rover steers off to the right and trundles slowly on a 500-yard trek toward its goal: a crude mockup of the Apollo 11 lunar lander base, spray-painted gold—an incongruous sight here on the banks of the Monongahela River in Pittsburgh.

In May 2010, a descendant of this rover is scheduled to visit the actual Apollo 11 landing site on the moon in an attempt to claim the \$25 million Google Lunar X Prize for its creators, Astrobotic Technology. A spinoff from Carnegie Mellon University's Field Robotics Center, Astrobotic is led by the center's founder, William Whittaker, known to all as Red.

Every other Friday, this second generation prototype of Red Rover—as the robot is named—goes for a test run here at Carnegie's Robot City, a 40-acre strip of shale and gravel at Pittsburgh's last working steel mill, which closed in 1997. Coincidentally, that was the year Whittaker finished his Ph.D.

out like some hooded wizard. A tall man, Whittaker habitually leans into conversations and speaks with a quiet intensity. That day, even as he was in hot pursuit of the DARPA prize, his mind was on the moon.

In fact, it has been for years. While NASA has focused on sending robots like Spirit and Opportunity to Mars, Whittaker says the moon has been "under-considered by the mainline space robotics community." And although he has built several robots for NASA, none has made it off Earth, let alone to the moon. So when the X Prize Foundation and Google announced their lunar contest on September 13, 2007, within hours Whittaker dashed off a check for the first installment of the \$10,000 registration fee and overnighted it to the foundation. "There was an immediate attraction" to the lunar competition, he says. "I saw it as being inspirational, visionary, a very bold step for robotics." Within 24 hours he assembled "a dozen compatriots" for the project. Among them were David Wettergreen, a CMU associate professor of computing who has worked with Whittaker on exploration robots for 20 years, and Sam Harbaugh, a 1958 Carnegie grad and systems engineer, "basically retired," who had returned to campus to help run all three DARPA challenges. Working with these and other experienced engineers are Whittaker's students, ranging from freshmen to post-docs. Sixty have signed up

RED WHITTAKER'S ROVERS HAVE ALREADY GONE WHERE NO ROBOT HAS GONE BEFORE. WILL ONE OF THEM MAKE IT TO THE MOON? BY GEOFFREY LITTLE • PHOTOGRAPHS BY JOHN FLECK

at Carnegie Mellon University and began building autonomous machines that would eventually explore active volcanoes in Alaska, map coal mines in central Pennsylvania, and search for meteorites in Antarctica.

Now one of the world's foremost roboticists, Whittaker, 60, recently added a racing title to his storied career. In November 2007 he won the \$2 million top prize in the DARPA Urban Challenge with a robotic vehicle capable of driving itself in simulated traffic over a 60-mile course. His hard-charging Chevy Tahoe, Boss, outran all 11 finalists, winning the final event by 20 minutes.

I first met Whittaker during that race, which was held in the California desert town of Victorville. Draping a red CMU sweatshirt over his bald head to shade his fair skin from the Mojave sun, he peered

for this semester's robotics course to help design and build Red Rover and its lander.

On the business side, Whittaker got back in touch with David Gump, a space entrepreneur with whom he had worked in the 1990s on a commercial proposal, LunaCorp, to launch a rover to the Apollo 11 site. Within weeks of reviewing the Google prize requirements, he and Gump realized that making another try at the moon would require a new company, and capital. So Astrobotic was formed, with Gump as president.

For a team to claim the Google prize, its robot has to land on the lunar surface, travel at least 500 meters (about a third of a mile), and send high-definition images and data back to Earth within 24 hours. The first team to do so will win \$20 million; bonus awards totaling \$5 million are offered for extras such



as photographing an artifact of previous lunar exploration, travelling more than 5,000 meters, and operating for a second (two-week) lunar day. To win the full award, the mission must be completed by the end of 2012, and 90 percent of the funding has to come from private sources. So far, 14 teams have announced their intention to compete for the prize.

Originally, Whittaker and crew targeted a landing at one of the moon's poles; the reserves of water ice believed to exist there would be useful to future lunar explorers. But ultimately "cultural interest" drove the decision: Astrobotic now intends to touch down near the Apollo 11 landing site in the Sea of Tranquillity and head off on a "Tranquillity Trek"—visiting the site of the first moonwalks, an area about the size of a soccer field, and sending back photos and video in near-real time.

In order for the rover to photograph itself on the moon (another Google requirement), the camera team is positioning a large parabolic mirror on the robot's side, much like a bus mirror. This should also yield a "money shot" showing sponsor logos, the rover, and (perhaps) Earth. (There's also talk of having the rover's bulldozer-like treads imprint a sponsor's logo or other design in the lunar dust.)

Red Rover will roll up as close to the Apollo lander as possible without trampling any footprints, and with its zoom lens try to photograph the famous "We Came in Peace For All Mankind" plaque on the lander base.

Whittaker has no doubt that his rover will be up to the task. "The tough nuts are the precision landing and a soft landing," he told the assembled Google Lunar X Prize teams and the press in May. "When we nail that, it's an easy journey. No matter what it takes, the robot will get us there."

WHITTAKER'S CONFIDENCE comes from a lifetime of working with machines. Born in 1948, he grew up mainly in Hollidaysburg, Pennsylvania, a railroad town nestled in a small valley near Altoona. His mother was a chemist who taught school, his father a World War II bombardier who later sold explosives for mining and road construction.

His parents encouraged him to roam, and by age six he was raiding the local junkyard for parts. One of his first constructions was a rocketship, with rudimentary propulsion cooked up from a chemistry set. At 16 he fixed up a Jaguar XK-120 (he ended up driving it for years), and he took a job swinging a hammer on the railroad lines, where he learned that bending iron requires as much finesse as brute force.

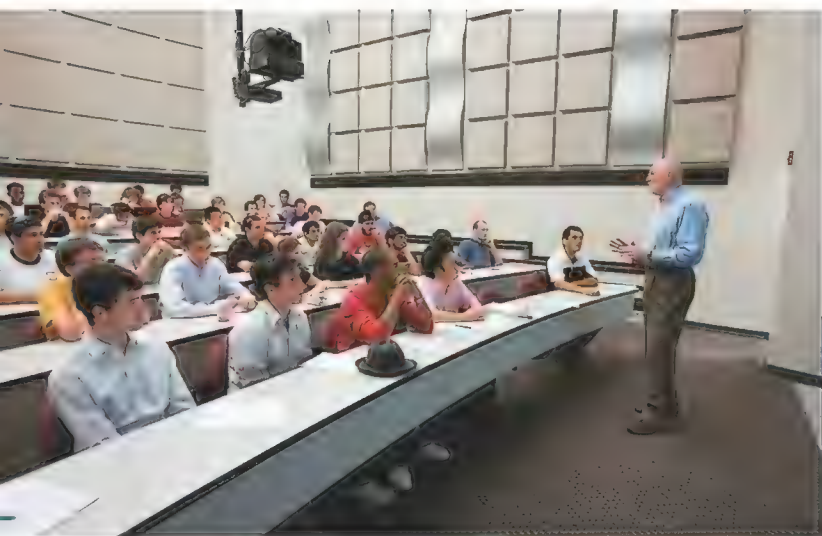
In the late 1960s, he left Pennsylvania for Princeton University, intending to study civil engineering, but interrupted his education to enlist in the Marines, one eye on the educational benefits. When Apollo 11 landed on the moon in July 1969, Whittaker was in basic training. He has no memory of the event; on Parris Island, South Carolina, he says, there was "no news in, no news out."

After two years of service, he returned to Princeton, G.I. Bill in hand. Following graduation in 1973, he continued on to Carnegie Mellon, where in 1979 he received his doctorate. That year, the Three Mile Island nuclear reactor in Harrisburg had a partial meltdown. In response, Whittaker and his colleagues began building robots to monitor and clean the reactor's contaminated basement. The experience spurred him to found CMU's Field Robotics Center.

🔵 **Carnegie Mellon's robot zoo includes SCARAB (above), a joint venture with NASA to design a rover for drilling on the moon, and Nomad, which roamed Chile's Atacama desert in 1997 as practice for planetary exploration.**



CARNEGIE MELLON UNIVERSITY ROBOTICS INSTITUTE



① Whittaker (left, lecturing at CMU's Robotics Center) considers his students integral members of the engineering team. Below: Dante II, a walking robot, rappelled into an Alaskan volcano in 1994.

In the mid-1980s, space beckoned. When NASA initiated a new class of low-cost Discovery planetary missions, Whittaker began pitching proposals, but none succeeded. The space agency did, however, fund a meteorite-hunting robot, Zoë, which the CMU team operated in Antarctica and Chile's Atacama desert. On another Antarctic expedition, a walking robot named Dante tried to rappel into an active volcano, but got stalled by a kink in its fiber optic cable. A later version, Dante II, descended into an Alaskan volcano, a simulation of the harsh conditions on other worlds.

Meanwhile, Whittaker continued building robots for dirty, dangerous, and difficult jobs on Earth. After the 2002 collapse of the Quecreek mine in central Pennsylvania, which trapped nine coal miners, Whittaker and his students built two subterranean robots, Groundhog and Ferret, to show that they could map mines and perhaps prevent future flooding accidents. In 2004, Whittaker entered the first DARPA challenge, which he won on his third try, in 2007. Not all of his machines have worked perfectly, but all have worked, and many have been built on a tight schedule.

On a visit to Robot City last summer, I saw the Astrobotic team putting the prototype Red Rover through rigorous testing. In the back seat of a van that serves as a makeshift mission control, CMU software engineer Nathaniel Fairfield and a colleague used three laptops to run the rover's navigation, safety, and control systems. The operators, who also wrote the software, could see what the robot saw as it drove, with a five-second delay built in to simulate actual moon operations. In some situations, the rover will have to "think" for itself without human input—for example, when navigating a slope.

"When are we in trouble?" asks Fairfield, his eye on a horizon indicator that would show if the rover were tilting too much.

"At 20 degrees," his copilot says.

"We're okay then." In Earth gravity, Fairfield explains, the rover stays balanced because of its weight. On the moon, it will be six times lighter, so a 20-degree tilt could place it in danger of tipping over.

The details for these and other operations are fig-

ured out in the three-story High Bay, the working heart of the Robotics Center, located back on the main CMU campus. There I see a small fleet of machines, all built by Whittaker and his colleagues. The meteorite-hunting Nomad stands sentry near the door, wearing the NASA "meatball" logo. A few yards away sits Zoë, the solar-powered rover that in 2004 roamed more than 120 miles through the Atacama desert. An automated boat, Sol, awaits a dip in nearby Schenley pond. It's a robotic wonderland.

At the far end, around the corner, is Red Rover's shop area. Nick Miller, who is pursuing his master's degree, shows me around. Having run through its paces, Red Rover now sits atop a rack, its solar panels removed to reveal wires, a central processing unit, and motors. This second prototype will be replaced by a third before next March. The fourth iteration—the flight version—now exists only as drawings on easel boards around the shop. In a nearby storage room, lead mechanical engineer John Thornton, wearing cargo shorts, and his team are fabricating their own carbon fiber parts. Thornton, who also has a master's from CMU, apprenticed at Boeing's Phantom Works.

Clearly, Astrobotic's operation relies heavily on student power. "Nothing great ever came from robotics



CARNEGIE MELLON UNIVERSITY ROBOTICS INSTITUTE



● At Carnegie Mellon's Robot City, engineers Jarrod Snider (left) and Bob Bittner stand alongside Boss, the autonomous vehicle that won the 2007 DARPA Urban Challenge.

in our corner of the world that hasn't had the energetic core of youth right upfront," Whittaker told a gathering of the X Prize teams last year. Still, he admits, when it comes to making decisions, "Red is the last word. I'm not being imperial or pushy. [But] is the program going to take another minute going down a blind alley?"

BACK AT ROBOT CITY, I sit in on a Technology Interchange Meeting, where the project partners are discussing today's engineering issues. A visiting team from Lockheed Martin is getting its first close look at Astrobotic's plan. Collectively, the Lockheed team members have decades of experience working on NASA planetary missions, from the Mariners of the 1960s to the current Mars Reconnaissance Orbiter. On the phone are representatives of Astrobotic's other partners: Raytheon, ATK, and the University of Arizona scientists who are planning the details of the Tranquillity Trek.

One of the topics at hand is Red Rover's mass. With all its gear and a lander package called Artemis, the rover is overweight—its mass is more than the intended launch vehicle (Astrobotic won't disclose their rocket supplier of choice) can lift. Not a huge problem at this early stage, but something that will need to be addressed.

The discussion moves on to the precision landing, a key part of Astrobotic's plan. The landing will rely on Raytheon missile guidance technology adapted from the company's Exoatmospheric Kill Vehicle. As the rover-lander descends to the lunar sur-

face, an onboard computer will update its flight path by comparing pre-loaded photos of the terrain to real-time pictures taken during the descent. The target ellipse is just 1,100 yards long and 330 yards wide—demanding a high degree of accuracy for a planetary lander.

Tom Gardener of Raytheon presents the numbers for the final descent. At around two and a half miles above the surface, a rocket will fire to slow the lander-rover from 7,900 feet per second to 330 feet per second. It's the equivalent of slamming on the brakes and diving down to the surface. At 23 seconds before landing, the main engine or smaller side engines will burn again for 2.5 seconds, further reducing the speed and setting up the soft landing.

The Lockheed engineers are concerned about this phase of the mission. To them it sounds very risky, "like falling out of the sky," as one puts it. Finally, Gardener says, "Look, guys, this is not a traditional spacecraft mission.... This is more like a missile operation." At the end of the two-day visit, the lead Lockheed engineer remains skeptical, but has changed his tune a bit. His verdict: The mission plan is "right on the verge of being possible." But, he cautions, "you have a whole series of nasty discoveries in front of you." For Whittaker, that means there's still plenty of work to do, but he considers the landing problem tractable. And once the rover arrives on the moon and rolls off on its journey, he says, "it's nothing that hasn't been done before" by an earlier CMU robot.

Except that now it has to be done on the moon, nearly a quarter-million miles away.

At the Jet Propulsion Laboratory in Pasadena, California, which has built all of NASA's planetary rovers, Rob Manning has been watching the Google Lunar

X Prize contenders with a mix of enthusiasm and skepticism. As the chief engineer for JPL's Mars program, Manning has a keen sense of what it takes to land and rove around on another planet. "Building robots that fly off Earth, land on another body, then interactively explore in a highly hostile environment requires a dazzling array of skills and technologies," he points out in an e-mail. "I hope that [Astrobotic] fully appreciates this reality. I live it every day."

Manning holds the individual members of Whittaker's team in high regard. "The good news is that they've got incredible talent," he says. But, he adds, "this is outside the box. It's not a car, it's not the DARPA challenge, not a missile. It's an all new thing—taking the best ideas from very different places and putting them together in a very weird, highly coupled way that's got to work the first time."

If Astrobotic can figure out how to test its systems in an integrated way on Earth, Manning thinks the missile-like landing concept can work, even with the ridiculously low (by JPL standards) \$100 million budget. "I think they have a shot at it," he says. When I tell him that Astrobotic hopes to raise enough money for two shots, doubling its chances of success, he is happy to hear it: "That's wonderful.... I want them to win."

Whittaker and his financial team are not counting on angels to bankroll them out of kindness. Their business plan is based on the proposition that, before NASA sets up a base on the moon, robots will be making maps and collecting data. If the Astrobotic rover makes it by 2012, or even 2014, when the Google prize expires, it will arrive years ahead of the astronauts.



With funding from NASA, a CMU rover named Zoë went hunting for signs of life in the Atacama desert in 2004. A descendant may someday do the same on Mars. The prototype SCARAB lunar driller (below) will be dispatched to Hawaii for testing.

It won't be an easy road. "Skeptics are everywhere," Whittaker acknowledges. Robert Richards, CEO and founder of the rival Odyssey Moon team, agrees: "As hard a challenge as this is technically, the real hard part is the business plan, and closing that business case."

So far, outside reactions to Astrobotic's plan have been drastically different from the reaction Whittaker and Gump got to their LunaCorp proposal more than a decade ago. It's not just the economics and NASA's attitude that have changed, says Whittaker. Technology has improved. "There was a time when you actually needed an immense infrastructure and engineering technical capacity to undertake this," he says. "What's occurred over those decades is that those tools...have gone from a foggy vision to reality." He cites a list of developments: Gyroscopes and accelerometers have evolved from complex spinning electromechanisms to "sensors on a chip." Batteries have doubled their energy density; cameras have vastly improved in resolution, durability, and miniaturization. And, of course, computer hardware and software have advanced steadily.

As for the schedule, if funding is slow to arrive, Whittaker has no problem slipping the 2010 launch date. "Not the kind of thing you get worked up over," he says flatly. Nor does he worry about the competition. "I definitely don't lose sleep over other teams," he says. "That would be a formula for losing."

Colleagues say that Whittaker is driven. Those who've worked with him for years can't remember when he last took a vacation. But he works on his cattle farm in central Pennsylvania to keep in shape, mentally and physically. "Right now I'm going to the moon," he says, "and that's not the thing that's going to stop me." So for now, Astrobotic has a man, a plan, a rover, and a rocket on deck, all waiting for one word: Go. ➤



CARNEGIE MELLON UNIVERSITY ROBOTICS INSTITUTE (2)

LEGENDS OF VIETNAM

More than three decades after the Vietnam War ended, Americans are still looking for ways to comprehend the country's longest war. With our series "Vietnam Memoir," published several years ago and available on our Web site, we focused on the experiences of airmen during the conflict. Fifty years after the first flight of the McDonnell F-4 Phantom II, we are revisiting Vietnam now to try to understand how certain types of aircraft took on starring roles in that war and shaped the plans for future warplanes. —THE EDITORS

Where Have All the Phantoms Gone?

HOW A FIGHTER-BOMBER-RECON-ATTACK SUPERSTAR ENDED UP AS FODDER FOR TARGET PRACTICE. BY RALPH WETTERHAHN

THE F-4 PHANTOM II LIVES. But the life it leads today is an odd one.

It still flies in other countries; in northern Iraq, for example, the Turks use it in combat with the Kurds. But in the United States, it leads a twilight existence. It's a warplane, but it no longer fights. Its mission is weapons testing, but no pilot flies it. Mostly, you'll find these F-4s either sitting in the desert or lying at the bottom of the sea.

The F-4 entered service in 1960, flying for the U.S. Navy. After studying its potential for close air support, interdiction, and counter-air operations, the Air Force added the F-4 to its fleet in 1963. Eventually the Phantom ended up even in the U.S. Marine Corps' inventory. In four decades

At Mojave Airport in California, old F-4s are readied for a new mission, with technicians painting parts drone-orange and installing remote-control equipment. Then the aircraft are off to serve, usefully if not heroically.



CHAD SLATTERY



of active service to the United States, the aircraft set 16 world performance records. It downed more adversaries (280 claimed victories) than any other U.S. fighter in the Vietnam War. Two decades later, it flew combat missions in Desert Storm.

In 1996 the aircraft was retired from the U.S. fleet. But the venerable McDonnell design has one last mission to perform for the military: to go down in flames.

Since 1991, 254 Phantoms have served as unpiloted flying targets for missile and gun tests conducted near Tyndall Air Force Base in Florida and Holloman Air Force Base in New Mexico. The use of F-4 drones (designated QF-4s) is expected to continue until 2014.

When an airframe is needed for target duty, one is pulled from storage at Davis-Monthan Air Force Base in the Arizona desert. The airframe is given refurbished engines and instruments, then sent to Mojave Airport in California. There, BAE Systems turns the aircraft into remote-controlled drones, installing radio antennas

and modifying the flight controls, throttles, landing gear, and flaps.

QF-4 production test pilot Bob Kay is responsible for testing the converted aircraft, then flying them from Mojave to Tyndall and Holloman. Kay has been captivated by the F-4 since the age of seven, when his father took him to an airshow. "I saw a Navy A-3 refueling two Phantoms as they flew over so low and with that noise," he says. "That's all I remember of that airshow, but I knew I wanted to fly that fighter."

I ask if he has any second thoughts about being part of a system that destroys an airplane he loves, an aviation legend.

He thinks for a moment, then says, "What better way is there for a warrior to end its life than to go down in a blaze of glory?"

THE PHANTOM HAS BEEN CALLED "double ugly," "rhino," "old smokey," and monikers even less flattering. The design does have its share of ungainly bends and

A study in power: This Vietnam War-era E model carries 500-pound bombs with extender fuses, which detonated the Mk 82 bombs just above the ground.

angles. The horizontal stabilizers droop 23.25 degrees. The outer wing sections tilt upward 12 degrees. When an engineer looks it over, the first thing that probably comes to mind is "stability and control problems." A brutal example of that weakness occurred during a May 18, 1961 speed record attempt. While Navy test pilot Commander J.L. Felsman flew below 125 feet over a three-mile course, his F-4 experienced pitch damper failure. The resulting pilot-induced oscillation generated over 12 Gs. Both engines were ripped from the airframe and Felsman was killed. (A later attempt succeeded.)

Control sensitivity varies widely. It takes full aft stick to raise the nose for takeoff, yet at certain fuel loadings and at speeds just above Mach 0.9 at low altitude, moving the stick only one inch can produce



NARA



COURTESY RALPH WETTERHAHN

Above: In December 1965, a formation of F-4Cs flies over Southeast Asia bearing 750-pound bombs. Left: The author in 1966. The F-4C pictured was later flown by legendary fighter pilot Robin Olds in the famous 1967 Operation Bolo, in which U.S. aircraft downed seven MiG-21s and sustained no losses.

Right: The author in a QF-4 drone. "I sensed it would be the last time I would ever sit in a flyable F-4," he recalls. "It was one of the hardest things for me to do to climb down."



MARK NANKIVIL

6 Gs on the airframe. At above Mach 2, on the other hand, the shock wave that is created moves the center of lift so far aft that pulling the stick all the way back produces only about 2 Gs.

With all its peculiarities and faults, legions have had love/hate relationships with the aircraft. "The F-4 is the last of the fighter pilot's fighters," says BAE's Bob Kay. "You have to *fly* the F-4." It has none of the bells and whistles of next-generation fighters. Instead of the multi-function flight displays found in modern fighters, the cockpit instruments are "steam gauges"—round dials with needles. It has an inertial navigation system, best described as cranky. There is no flight management system, no GPS, no Electronic

Flight Instrument System (EFIS), and no "Bitching Betty" voice system to alert the pilot to hazards. You have to navigate, bomb, shoot missiles, fire the gun, look for problems, and evaluate every one of those actions instrument by instrument. For the pilot, this means a lot of time is spent head down, analyzing instrument data; in modern aircraft, on the other hand, much of the information is presented compactly, in head-up displays above the instrument panel.

My affair with the Phantom began upon graduation from pilot training in 1964, when I landed a tour in the Air Force F-4C. Though the Navy and Marine Corps assigned radar operators to the "pit," as we referred to the second seat, the Air Force

thought it would be more effective to use the configuration for two pilots. *Wrong*. No true fighter pilot chooses to serve as copilot. The assignment was akin to a shotgun marriage. For two years I languished six feet behind my more experienced comrades, calling off altimeter readings as they bombed, strafed, and fired rockets in training exercises on the gunnery range. Back-seaters had to beg, cajole, and whine for stick time, and when we got it, we found that every aspect of flying the F-4 from the rear cockpit was a nightmare. The meager instruments were placed haphazardly in a straight line across the panel. The useless clock and G-meter were located in the center. Why? Because they fit there! Instrument approaches gave you a migraine. And to spot the runway, you had to peer through a knothole on either side of the cockpit, which made landing from the pit an adventure, especially with a crosswind.

Front-seaters were not always thrilled with the F-4 either. In 1972, during his second tour in Vietnam, U.S. Air Force Major Dan Cherry, now a retired brigadier general, flew 185 combat missions in the Phantom; today he recalls: "The F-4 cockpit was uncomfortable, the instruments were poorly arranged, crew coordination was a hassle, it was ugly, and it used fuel like nobody's business."

Crews that flew the airplane for the Navy had their own share of problems. By 1966 the Rolling Thunder bombing campaign waged by the Navy and Air Force had really heated up. Large formations of fighter-bombers were striking targets in the Hanoi area daily. That year Commander Dick Adams' squadron flew combat in F-4s off the carrier *USS Franklin D. Roosevelt*. Each Phantom launched from the Rosie's short catapult with four 500-pound and four 1,000-pound bombs, plus an empty centerline tank, which was refueled during climbout. Before a carrier landing, Phantoms had to achieve a certain landing weight; landing heavy would overstress the arresting cables. For this carrier, the F-4 was a heavy aircraft, and as such could try an approach with fuel for only one or two attempts. On the 1966 cruise, one of the squadron jets on a landing attempt was waved off, and when the pilot ran out of fuel before completing a second pattern, the engines flamed out and the aircraft went deep-six. The crew survived.



McDonnell F-4E Phantom

The E variant changed the game for F-4 pilots. Previous versions had drag-producing externally mounted guns. But F-4Es had internal guns, housed in their noses, and some had leading-edge wing flaps, which enabled tighter turning and better dogfighting performance. (The E above, *Betty Lou*, operated out of Korat Royal Thai Air Base in Thailand, serving the 469th Tactical Fighter Squadron, which conducted interdiction missions in North Vietnam and Laos.) The U.S. fleet is now retired from combat, but Phantoms are still active in Egypt, Turkey, Greece, Germany, Japan, South Korea, and Iran.

In March 1966, I was told that if I agreed to take a combat tour, I'd get the front seat. *Are you kidding?* I made my first front-seat flight at MacDill Air Force Base in Florida. I still remember it: a gunnery mission. And oh, the visibility from the front chair! My landing was the smoothest of

"grease jobs." At that moment, the shotgun marriage turned into a love affair.

After passing my checkout flight, I was stationed at Ubon Air Base in Thailand, a member of the 555th—"Triple Nickle"—Squadron in Colonel Robin Olds' famed Eighth Wing.

At Ubon, the F-4 was all things to all people. One squadron flew only at night, popping flares and dropping bombs. The other two squadrons flew both day and night, dive-bombing bridges, strafing ground targets, rocketing truck parks, and tangling with the ever-elusive MiGs over Hanoi.

On October 11, 1966, I discovered how tough the Phantom was. An 85-mm round blew a four-foot section off my right engine, and the aircraft caught fire. Still, it held together through the 400 miles back to Ubon.

By the end of 1966, the Phantom had revealed a host of shortcomings. Number one was the dismal record of missile hits against the North Vietnamese MiG-17s and MiG-21s. The AIM-7 radar-guided missile had a probability of kill below 10 percent. Richard Keyt, who flew F-4s for the 35th Tactical Fighter Squadron during the Viet-



In 1961, this F-4H set a low-altitude speed record: flying below 125 feet at 902.8mph. The record is unbroken today.

KEITH FRETWELL VIA AEROSPACE PUBLISHING LTD.



MARK BENNETT

F-4s at Arizona's Davis-Monthan Air Force Base, the warplane retirement home.

nam War, recalls: "Our missiles were designed to work in a non-maneuvering environment—a non-turning, 1-G shot at the bomber target flying straight and level at high altitude." The reality: "F-4s fired in high-G turns at small MiGs that were turning hard and pulling Gs." To remedy the problem, the Air Force expanded its Weapons System Evaluation Program (WSEP) at Clark Air Base in the Philippines. Combat crews were given practice in firing missiles at towed radar-reflective targets.

My backseater, First Lieutenant Jerry K. Sharp, and I took part in that exercise over the South China Sea in December 1966, scoring a hit. On January 2, 1967, we used the skills we had honed in that exercise when we merged with a flight of four MiG-21s that were turning hard to get at us. Sharp got a radar lock-on while under heavy Gs. Then I centered the steering dot, fired two AIM-7s, and watched as the second missile exploded and tore the tail section from the MiG in front of us.

For other F-4 shortcomings, the military contracted out quick fixes. Modifications included the installation of Radar Hom-

ing and Warning (RHAW) gear—a cockpit system that alerted pilots when their aircraft was being tracked by anti-aircraft-artillery radars or surface-to-air-missile sites. Also added were radar jamming pods, plus chaff and flare dispensers used in combination to confuse tracking radars and to dupe radar-guided or heat-seeking missiles.

The C variant had a number of design problems; one of the biggest was lack of a gun. The rules of engagement over Vietnam required that an adversary be identified visually before a missile could be fired at it. The MiGs were small, and to make the ID, shooters had to get close, often much



LEFT: MARK NANKIVILL; RIGHT: CHAD SLATTERY



Dressed in drone livery, QF-4s are targeted during weapons testing (below: one takes a fatal hit). The testing is done at two Air Force bases, Tyndall in Florida and Holloman in New Mexico. F-4s replaced converted F-106s as the military's drone of choice. Also droned in their time: F-86 and F-100 fighters and F-102 interceptors.

less than the minimum distance that the AIM-7 radar-guided and AIM-9B heat-seeking missiles required to hit a target. At short range, "if you didn't have a gun, you couldn't shoot down anything," says Richard Keyt. The quick

fix was the SUU-16/A gun pod with the M61A1 20-mm cannon.

But without a lead-computing sight and with no tracer ammunition, F-4C pilots were denied the visual cues needed to correct aiming errors. Then, in 1967, the F-4D arrived. The D model introduced a lead-computing optical sight for use with the gun pod. In addition, the normal ammunition load now included tracers.

On November 6, 1967, the gunfighter Phantom proved its worth. Captain Darrell "D" Simmonds and First Lieutenant George H. McKinney Jr. were escorting a flight of F-105s that came under attack by two MiG-17s. "We picked up the MiG-17s visually that were shooting at the Thuds [F-105s]," says Simmonds. "I was able to get in there and maneuvered for a perfect 'up-



USAF



TYNDALL AFB

hill dart' shot. I hit him, came alongside, and looked at him, and he looked at me, then ejected just before the plane hit the trees." McKinney spotted another MiG-17 and Simmonds swung into a hard turn, accelerating as he lined up for the shot. "We were close, but I didn't want to miss the opportunity," the pilot remembers. "I fired and he blew up." Later, Simmonds realized: "We had used just 497 rounds for the two kills—less than five seconds of firing."

The D model, however, was not a cure-all. "The guns on the D hung externally, on the centerline, and that created drag," says Keyt. As for the missiles, the underperforming AIM-9B was abandoned for the Hughes AIM-4D Falcon. Designed to bring down strategic bombers, it required cooling of the seeker head prior to launch and needed a direct hit to score a kill. As

pilots found out during what became known as the "Falcon Fiasco," it came up short in a dogfight. Major James R. Chamberlain, a backseater stationed with the "Gunfighters"—the 366th Tactical Fighter Wing at Da Nang—notes, "The biggest problem with the AIM-4D was the limited amount of cooling time available [two minutes or less], which meant that the missile could not be pre-cooled for a quicker lock-on. And, once available liquid nitrogen was consumed, the missile was a blind, dead bullet—derisively called the 'Hughes Arrow.'" After firing four of the missiles in combat without success, Robin Olds insisted the missiles cost him his fifth kill. He ordered them removed from his fleet.

The Air Force soon trashed the AIM-4D. Newer Sidewinders were substituted. The military also recognized the benefits of an internal gun: The F-4E, introduced in 1967, had an M-61A cannon mounted beneath a solid-state AN/APQ-120 radar, both inside the aircraft nose. During the time Richard Keyt's 35th Tactical Fighter Squadron was based at Korat air base in Thailand, five squadron aircrews were credited with MiG kills, and four used the internal gun.

In 1973, during my third tour in Southeast Asia, I was assigned to the early E model. It was a dream to fly, not only because of the improvements made in gun and missile technology but also because the Air Force had realized the folly of putting two pilots in a fighter. After 1967, virtually all the GIBs—guys in back—were either navigators or radar intercept operators.

The follow-on Es brought enhancements: A horizontal tailplane with a fixed inverted



RALPH WETTERHAHN

Left: BAE installs digital systems for remotely controlling the drones' steering, throttles, flaps, landing gear, brakes, and more. Opposite, right: Arming an explosive charge, for use if control of the drone is lost. When the \$2.6 million, four-month conversion is complete, the drone is ready to take off (opposite, left).

At the 2007 Aviation Nation show in Las Vegas, a Phantom (at bottom) takes an honored position in a heritage flight with a P-51 Mustang (in front), an F-22A Raptor (at top), and an A-10 Thunderbolt II.

slat gave improved control at high angles of attack. Leading-edge slats on the wings enabled tighter turns at slow maneuvering speeds. A Northrop system called TISEO (target identification system, electro-optical) identified airborne targets.

By the time my final tour was up, in 1974, a fleet of Phantom variants had safely taken me through a gauntlet of fire and flying experiences that would constitute the greatest adventures of my life.

THREE-PLUS DECADES LATER, I was once again in the company of Phantoms. This time the setting was the tarmac at Tyndall.

The commander of the 82nd Aerial Target and Recovery Squadron, which conducts the drone shootdowns, is Lieutenant Colonel J.D. “Bare” Lee. A former F-16 pilot, Lee also has 1,500 hours in the Phantom. He still recalls the first time he took to the air in one. “I was shocked at how much more difficult it was to fly than I thought it would be,” he told me. “When I got home, I told my wife, ‘I think I just traded in a Porsche for a ’72 Cadillac.’”

At any one time, a total of up to 80 F-4s are stationed at Tyndall and at Lee’s Holoman detachment in New Mexico. Twenty-one Phantoms sat on a ramp called the Swamp, awaiting movement to Death Row, the holding area for the soon-to-be targets.

At mid-afternoon the drone mission



briefing took place. The meeting included the drone “fliers,” Lockheed Martin personnel headed by pilot/controller Matt LaCourse. “Today’s mission is in support of WSEP, so there’ll be a lot of shooters out there,” said Lee. “WSEP” is the same Weapons System Evaluation Program I had participated in four decades earlier

in Vietnam, when I’d practiced shooting at towed targets from F-4s. Now the F-4 was the target.

LaCourse explained that four F-22 Raptors would each fire the latest AIM-120 air-to-air missile. The shooters and chase plane would take off from the main runway, while the drone used a strip three miles east.

Most Phantoms wind up in the Gulf of Mexico within one to three missions. But not all: One, nicknamed “Christine,” after the Stephen King book and film about a crazed car with a mind of its own, had survived 10 missions. Another, “Son of Christine,” has come back from 12 sorties, the current record.

Some drone missions are not meant to be shootdowns: The Phantom is loaded with missile jammers, and missiles without warheads are fired against the craft to test how well the jamming works. Other Phantoms are spruced up with Vietnam War-era camouflage and flown to airshows.

One Phantom was saved by its former pilot. On April 16, 1972, Dan Cherry, flying an F-4D, had scored a victory over a



BOEING MEDIA



CHAD THOMAS/JETWASHIMAGES.COM

North Vietnamese MiG-21. Thirty-two years later, during a trip with friends to the National Museum of the Air Force in Dayton, Ohio, Cherry encountered the aircraft he had flown that day. It was on display in the little town of Enon, outside Dayton.

"In spite of her flat tires, weeds growing up all around, bird droppings everywhere, and faded gray paint, she was beautiful," he recalls. "Walking around her and answering my friend's questions made me realize how much I loved her and how much I owed her for taking such good care of me. Suddenly all those things that seemed like negatives before paled in comparison to the strong bond I felt at that moment." Cherry took on the task of relocating the aircraft to the Aviation Heritage Park in Bowling

Operating from the USS *Constellation* (opposite, below) during the Vietnam War, the Marines used Phantoms as tactical recon craft (RF-4Bs). F-4s were the only aircraft to serve the demonstration teams of the Navy (right, in England in 1973) and the Air Force simultaneously.

Green, Kentucky, where it was restored and is now displayed. Then he decided to learn about the pilot of the MiG he had shot down. (Cherry's story about meeting his former enemy in Vietnam will appear in a future issue of *Air & Space/Smithsonian*.)

At Tyndall, the heat and humidity hit my face like a wet washcloth. The van driver took us from Death Row to the end of the runway, where F-4E tail number 73-1165 was positioned about 20 feet to the right of the runway centerline.

I asked if I could approach the aircraft. My unit escort, Major Kevin Brackin, obtained permission. I got out of the van and walked across the concrete. When I reached the aircraft, I placed my hand on the radome. Because of the cloud cover, the nose was warm to the touch, not the usual egg-frying hot. The Phantom felt alive.

I felt a wave of dread. Within minutes this magnificent machine might be in pieces at the bottom of the Gulf of Mexico.

A photo was taken, and I headed back to the van to listen to the radio chatter.

Lee says it cost the Air Force \$2.6 million to get the aircraft from the boneyard in Tucson to the runway at Tyndall. Is it worth it? "The F-4E has the built-in ability to launch flares and chaff and can carry an assortment of jamming pods, all of which put our latest weapon systems through their most rigorous tests," says Lee. Had we taken the time to test our missiles properly in the early 1960s, the Vietnam air war might have turned out like the one over Baghdad: a clean sweep.

We positioned ourselves behind the drone to await the launch order. Both engines were started. The canopy was closed, and the self-destruct bomb was armed for use in case the drone went out of control. Finally, the intake screens in front of the engine inlets were removed.

Then came an ominous ground transmission: The "shooter aircraft have problems," and a storm cell had slung cloud layers over a wide swath of sky. We sat and waited.

Finally, after a 15-minute delay, the mission was ordered back on.

The drone launch order was soon passed, and the operators got the Phantom rolling. LaCourse made a correction to get the aircraft precisely on centerline as both afterburners lit. Fifteen seconds later, I watched the pilotless aircraft take off.

The F-4 proceeded out over the gulf. The first aircraft fired its missile. The ground controller monitoring the telemetry radioed the air crews: "No hit."

The Phantom flew on.

My emotions tangled: I wanted the aircraft to survive, but I also wanted it to fulfill its intended mission.

The four F-22 Raptors spread out. Each launched a missile. Over the radio we heard "Fox-four"—all shooters had fired.

Then: "Splash." A direct hit.

Brackin and I walked back to the van and got in. Brackin was staring straight ahead. Then he turned to me. "So now you know," he said, grinning. "It takes four Raptors to kill an F-4." ✈



RICHARD VANDERVORD

ALTHOUGH I'M SITTING in the living room of a second-floor condominium in Germantown, Maryland, what I see on the monitor of Dan Ward's Dell computer invites me to imagine I'm in the cockpit of an Embraer 145 regional jet. Visible through a cockpit window is the jetway, which runs from the passenger door to a gate at Terminal 3 of Chicago O'Hare. The cockpit instruments are dark, but after Ward types in a few commands, the control panel lights up like a Christmas tree.

Soon Ward, senior pilot for Delta Virtual Airlines, is keying flight data into the flight management system, the automated device that will fly the Embraer 145 from just after takeoff to just before touchdown while he sits back, monitors progress, and talks to air traffic control. Then he types in the departure and arrival airports (KORD and KATL), flight plan (CMSKY CARYN CYBILPXV J73 BNA ERLIN5), initial climb rate, cruise speed, altitude, fuel reserves, winds aloft, number of passengers, and so on. The entire process takes about 10 minutes. Finally, Ward is ready to go.

Chicago Approach: "Delta 6461, you are climbing out of my airspace. Chicago Center not online. Radar service terminated, frequency change approved. Thanks for flying."

And with those last three words, the simulated flight ends. Breaks in radar coverage are nothing new to Ward, who in real life is a 57-year-old systems engineer for General Dynamics. As a student at the Naval Academy, he logged about 75 hours in different aircraft, but these days Ward spends his time on one of the hottest digital pursuits aloft or on the ground: the virtual airline game.

Virtual airlines mirror real-world airlines. Although it might come as a shock to most passengers (as well as their flight crews) who are plowing through the skies on any given day, there are also, on that same day, hundreds if not thousands of virtual pilots flying the same, though virtual, routes. The Web site *www.avsim.com* ("Simulation's Premier Resource!") lists a total of 326 "Passenger Oriented VAs," including Delta Virtual and American Vir-

Air Cargo, *upsvac.com*, now includes a disclaimer saying, in part: "This virtual airline is operated by aviation and simulator enthusiasts. All 'real' logos of UPS (United Parcel Service) are copyrighted material for the corporation of UPS (United Parcel Service). We are not affiliated with UPS (United Parcel Service)."

Delta Virtual Airlines' own Web site, *deltava.org*, also includes a disclaimer ("We are in no way affiliated with Delta Air Lines") but is otherwise hyper-authentic. Here you will find predictable stuff like Delta Virtual Airlines news, a fleet gallery (with images of real-world Delta jets), and a "Who Is Online" link. Further down the page is an archive of Delta VA's inflight magazine *DELTA FLY!*, a "Water Cooler" forum that logs 300 to 400 posts per day, a pilot roster, and a pilot locator, which depicts a map of the world dotted with teardrop-shaped pushpins, many of them clustered around big cities. Clicking on a pushpin brings up a balloon giving the pilot's name, Delta ID number, and approximate home base. "Approximate" be-

WELCOME TO

As the jetway moves aside, Ward requests push-back. He starts the engines, which make a *whoosh* in the background, then speaks into his voice-activated headset: "Chicago Arrival, Delta 6461 with you, IFR to Atlanta."

Chicago Approach: "Delta 6461, Chicago Approach, standby one." (*Beep*. Long pause.)

Ward is calling Approach for a departure because today's virtual controller is multi-tasking and playing a variety of roles.

Chicago Approach: "Delta 6461, have your clearance. Ready to copy?"

Delta 6461: "6461's ready to copy, sir."

Soon Ward is off the ground, with downtown Chicago and Lake Michigan coming into view through the left side of the cockpit.

Chicago Approach: "Delta 6461, radar contact. Climb and maintain one-three thousand, direct CMSKY."

"Nominal," as they say. But then a few minutes later, at about 10,000 feet:

tual Airlines and such offbeat specimens as Air Seychelles VA and Ocean RIA/Ocean Airways, which AVSIM describes as "a German airline based in Palma de Mallorca." Then there are virtual charter and bush airlines (22 total), virtual cargo-oriented airlines (19), and 57 virtual airlines that don't fit into other categories.

Nor are these outfits merely imaginary entities or complex, extended jokes. Each virtual airline has its own Web page, some of which are detailed, realistic, and sophisticated beyond belief. "There used to be a UPS Virtual," says Terry Eshenour, Delta Virtual Airlines' president and CEO. "They had a cease-and-desist order because they were using [UPS] logos, and it was difficult to differentiate whether you were dealing with UPS or UPS Virtual." (The Web page for today's UPS Virtual

cause Delta Virtual Airlines emulates real-world airlines' tendency to suppress and distort certain information "for security reasons.")

Even more impressive is the Web site's live map: Based on the real world's Airline Communications Addressing and Reporting System, the map shows the current status of Delta Virtual Airlines' flights, using color-coded pushpins to show whether the flight is on the ground, climbing, descending, or at cruise. Clicking a given pushpin brings up a trove of information that borders on the surreal: the pilot's name, rank, and Delta VA seniority number; the flight number and type of aircraft; its departure and arrival airports; its exact geographical coordinates in degrees, minutes, and seconds; its airspeed, ground speed, vertical speed, and

■■■■■ **Opposite: Every day, a network of virtual air traffic supports thousands of takeoffs (top). Around the world, people like Luke Kolin (middle) log hours at their computers as virtual pilots, while others work at elaborate stations (bottom) as virtual air traffic controllers.**



CYBERAIRSPACE

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Inside a virtual cockpit: A Boeing 757's overhead panel (top); beginning a takeoff roll on Runway 26 Left at Hartsfield-Jackson Atlanta (above).

Mach number; heading; percent of rated power in N1 and N2 compressor engine sections; total fuel flow in pounds per hour; autopilot and auto-throttle settings. If you want more, you can superimpose the airplane's current position on a Google Earth map.

While tracking virtual aircraft is easy, knowing the exact locations of flight crews is less so because virtual pilots are not required to remain seated in their virtual cockpits for entire flights. While flying from Atlanta to Tokyo, for instance, Eshenour flew a Delta airliner as far as Alaska, then turned the flight over to the aircraft's flight management system and went to bed. He woke up in time to start the descent and made an on-time landing. Such allowances might seem like cheating, but real-world pilots do almost the same thing, napping in crew rest ar-

reas on long-distance flights while copilots take over.

The question arises: Why do a bunch of sane, calm, and levelheaded people go to such extremes to make something essentially fake seem real?

"This is a way to live out the fantasy," says Eshenour. He had always loved airplanes and aviation, but had no desire to learn to fly. Now retired, he had been in upper management at the Coca-Cola Company. He was responsible for introducing the company's Minute Maid brand to Japan, where he and his wife lived for two years. Somewhere back in the 1980s, he bought a copy of Microsoft Flight Simulator and played it on his home PC.

"In Japan I was using this as a personal escape," he says. "You can set up in your mind some goal you want to achieve: You want to go someplace, you want to do

things under certain conditions. And when you're pursuing that, you can block out anything around you."

In 1988 he came back to the States and worked at Coca-Cola headquarters in Atlanta. He bought a new computer and an upgraded version of Flight Simulator. "The version for the year 2000 had something in it about 'online flying,'" he says.

Online flying, it turned out, was simulated flying with the added attraction of air traffic control. The surprise was that the air traffic control experience was not part of the Flight Simulator program, nor was it any sort of add-on program. (There are tons of add-ons and plug-ins for simulated-flight enthusiasts: ones for combat flying, navigation, route planning, and crew scheduling, among others.) Instead, air traffic control was provided by real live people wrapped up in their own pet simulation: virtual air traffic control.

For a virtual pilot such as Eshenour, who had been doing all of his simulated flying, crashing, and burning in the privacy of his own home, the question was whether to go public. It was in fact a big decision.

"What happens when you're online and you have ATC on the other side and they can see you, and you screw up?" he asks. "Really, they can see you screw up! Am I going to be confident enough to do that as an aviator? Do I really understand how to communicate and to navigate under ATC and under IFR [instrument flight] rules?"

Eshenour's fears were not without foundation. Just like real-world pilots, virtual pilots have taxied into terminal buildings, overrun runways, and collided mid-air with other aircraft. In the beginning, Eshenour's specialty was crash landings. "These days I go around more than I crash," he says.

As if it weren't enough of a challenge to fly a virtual airliner safely, some virtual pilots look for additional responsibilities. Take Luke Kolin, a cyber airline pilot based in Atlanta. Originally from Toronto, Kolin got a degree in history but was also an exceptionally accomplished computer geek, who, as a teenager, operated his own online bulletin board. In 2001, he decided to get involved in the creation of a virtual airline, one that had all the trappings of a real airline: a fabulous fleet, complex route structure, crew

COURTESY DAN WARD (2)

training, a rigid system for getting promoted up the ranks, and so on. Since he lived in Atlanta, the home base of Delta, why not make it Delta Virtual?

Headquarters was initially a server in Kolin's bedroom. (Nowadays the Delta Virtual Airlines server is operated by a commercial firm.) Today, seven years later, Delta VA is the world's largest virtual airline, with 2,500 active pilots. Anyone 13 and over can join, and membership is free (operating costs are voluntarily funded by a dozen or so members). "The only thing we ask of a pilot applicant is that they have an interest in aviation and a valid e-mail address," says Eshenour.

Since the whole *raison d'être* of Delta Virtual Airlines is to enhance pilot enjoyment through knowledge and experience, company policy dictates that a type rating in a given aircraft requires a written examination and a check ride, which is a 30- to 45-minute test of skills under the supervision of a Delta Virtual Airlines certified flight instructor. Senior Captain Dan Ward (who also flies for United Virtual and three other cyber airlines) has type ratings in more than two dozen aircraft. ("I have check rides in all of them," he says.) Delta Virtual operates its own

flight academy and publishes flight manuals for the aircraft in its fleet. Some of those in Ward's bookcase run to 300 pages, "and I actually read them before flying the plane."

Does all this mock flying actually increase proficiency in any real-world sense? Eshenour recalls the time that he and Kolin got a chance to fly not a real-world Delta jet but the next best thing: Delta's real-world training simulator in Atlanta. It's basically a 737 cockpit on hydraulic legs, which enable actual movement in pitch, roll, and yaw. Real-world Delta pilots have sweated through countless simulated emergencies, missed approaches, and other tortures in the device.

"He and I sat down in the 737-800," says Eshenour. "He sat in the left seat, I sat in the right seat, and we said, 'Okay, put us in Philadelphia at the runway threshold, and we're going to fly and land at JFK.' We knew what the winds were and what runway we wanted to land on, and we punched into the FMC [flight management computer] where we wanted to go. We set the flaps and took off and flew it. And landed! At Kennedy!"

"I don't want to say it was the prettiest approach and landing," he adds. "But we got it down on the centerline, at the right speed, and we didn't break the struts, and we didn't do a tail strike—all of which we did before, in a 767 [simulator], at Salt Lake City."

Short of actually leaving the ground, flying a hydraulic simulator is as real as it gets. Flying Microsoft Flight Simulator, by contrast, is a heavily compromised experience. For one thing, unless you're equipped with a "simpit," a simulated cockpit, which is a relatively rare commodity in the online world, it's all too clear that what you're really flying is a computer. Although the images on the screen may impart a temporary illusion of motion, in reality nothing moves except your hands (and feet, for those who

Terry Eshenour, in a Boeing 767 simulator (right), is the president of Delta Virtual Airlines. The company's pilots can track virtual Delta flights through a color-coded live feed superimposed on a Google Earth image.



COURTESY TERRY ESHENOUR



DELTA VIRTUAL AIRLINES



DELTA VIRTUAL AIRLINES



COURTESY MARIANO BUITRAGO

Flight simulation software enables pilots to view their aircraft from outside the cockpit – at any angle (above). When he’s not working as a virtual air traffic controller, Mariano Buitrago likes to fly in a friend’s Boeing 737 cockpit replica (left).

have rudder pedals). And while the on-screen images have gotten more realistic over the years, there is still an element of artifice and staginess to them: They’re canned, cartoonish.

None of this holds true for another kind of simulation, the very one that makes the existence of virtual airlines possible: virtual air traffic control.

Virtual air traffic controllers spend their time looking at a display screen, but so do real-world controllers. The similarity makes all the difference in the authenticity of the simulation, especially considering that the images that appear on

the two kinds of screens—real and virtual—are functionally indistinguishable.

Mariano Buitrago lives in Leesburg, Virginia, which coincidentally is the home of the real-world Washington Air Route Traffic Control Center. Buitrago, who is originally from Managua, Nicaragua, is an engineer and MBA with a day job at a large financial company in Washington, D.C. He spends many of his night hours controlling simulated airline traffic from his home office.

“I’ve had the aviation bug for my entire life,” he says. “I grew up reading *Flying* magazine.” But because his family considered being a pilot risky, he never took flying lessons. He did, however, learn Flight Simulator, which is where, “like most people, I stumbled across VATSIM.”

VATSIM, otherwise known as the Virtual Air Traffic Simulation Network, is an organization created in 2001 to provide voluntary air traffic control services to FlightSim pilots. On its Web page, vatsim.net, VATSIM notes that the early FlightSim experience “was a very lonely proposition. There were no other airplanes in the skies while we flew en route, and our arrivals at major airports were like landing in ghost towns.”

All that changed with the dawn of virtual air traffic control, a phenomenon made possible by the Internet and new software. One early program, called Pro-Controller, turned an ordinary computer monitor into a virtual radar screen. Servers programmed with complex networking software enabled simulated flights to show up on the radar screens of several different controllers.

Individual virtual flights were hooked to the network by an add-on program called SquawkBox, which transmitted an aircraft’s flight data to VATSIM; in addition, it allowed pilots to communicate with air traffic controllers either by text messaging or by voice, using a headset and microphone. For Buitrago, all of this was a dream come true. “I started out as a student controller in 2004, and worked my way up over a period of two years to be a senior controller,” he says. “There’s a very strict hierarchy in VATSIM. I started in Washington Center and have been there ever since. I was deputy manager for two years, and then manager for about a year and a half.”

You might think of Buitrago’s home office as Washington Center’s control room. It’s a small, downstairs den with

bookcases laden with IFR charts. On a desk are two monitors, each wired to its own central processing unit. Front and center is the monitor hosting the virtual radar client. On a black background, the various sectors and components of Washington Center's airspace show up in color: airways, cities, airports, radio towers and other navigational aids. Prohibited areas such as P-40 (Camp David) and P-56 (the White House, Pentagon, and U.S. Capitol) are red.

Flights in progress appear as "tags," colored blocks of text that give, among other things, the flight's points of origin and destination, ground speed, altitude, transponder code, and whether it's in cruise, climb, or descent. A line to the left of the text block indicates the aircraft's heading.

At this precise moment Buitrago's radar screen shows about eight targets. He dons his headset and connects to the system (he arranges with other controllers in Washington Center on when to participate). From the controller he's about to replace, he learns about aircraft on the ground at Reagan Washington National Airport, waiting for clearances. Then, by text messaging over ChatBox, he informs other controllers in the area that he's about to be up and running. And all at once this 42-year-old MBA magically becomes...Washington Center!

A United flight checks in.

United 4347: "Washington Center, United 4347 climbing out of one six thousand for one seven thousand."

Washington Center: "United 4347, Washington Center, good evening. Climb and maintain flight level two-seven-zero."

"The guy who wrote this VRC [virtual radar client] went so far as to add a filter to distort the voice so it sounds like a VHF radio," says Buitrago. "Otherwise it would sound too clear, too perfect."

Both virtual pilots and virtual controllers make every effort to mimic real-world air traffic control phrasing and speech cadences, as well as its elaborate politeness and formality.

Buitrago's other display screen, to his immediate right, is for "flight strips," which

are also artifacts of real-world air traffic control. A flight strip is a rectangular box that duplicates much of the information found in the radar tag but also includes such data as the aircraft's alternate airport for landing and its complete flight plan.

A flight strip for United 4347 suddenly appears. Soon there are several more on the flight strip screen.

All of this is hyper-realistic with one exception: Whereas a real-world Air Route Traffic Control Center's functions would be divided among several controllers, one each for clearance delivery, ground control, departure, and arrival, on this particular Monday evening Buitrago is playing all roles himself for Reagan National.

Cactus 2579: "Washington Center, Cactus 2579, standing by, clearance."

Washington Center: "Yes sir, 2579, you're cleared to Tampa as filed. Maintain five thousand, expect flight level three-four-zero 10 minutes after departure. Departure frequency is one-two-three point eight-five. Squawk zero-five-zero-two."

And so it goes, for as long as you want. Sometimes, during Friday ops, when lots of pilots are flying, virtual air traffic controllers can get real-world levels of traffic. Buitrago, who has a wife, three kids, and a dog, usually limits himself to an hour and a half or maybe two of VATSIM controlling a few times a week.

"Do you ever get nervous doing this?" I ask him.

"Yeah," he says. "You sweat."

He'd sweat even more should there occur on the screen any flying that consti-

tuted a threat to public safety, whether it was an inadvertent entrance into restricted airspace or an intentional flight into a building or nuclear power plant. Virtual air traffic controllers can at their discretion report such actions to VATSIM supervisors, who are always monitoring events. Virtual pilots who engage in acts of simulated terrorism face a range of sanctions, the most serious being a permanent ban from the network. And just as there are virtual airlines, VATSIM has virtual armed forces, though they have not been as active recently as they have in the past. If some of the virtual armed pilots were online during a security incident, however, they could be ordered to intercept.

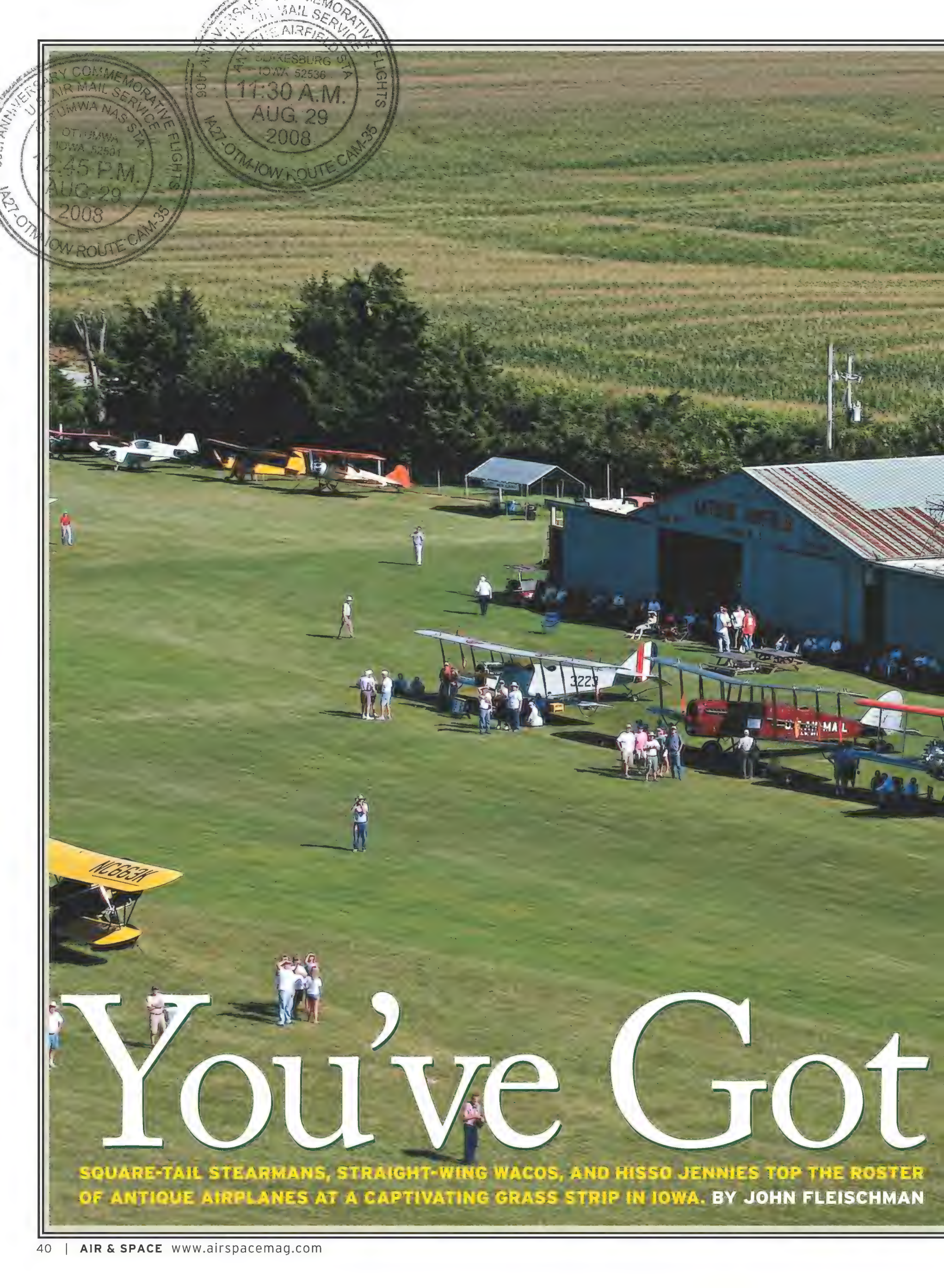
If both virtual airline flying and VATSIM air traffic control are indeed this realistic, exactly where does all of it take place? These things are not just imaginary, existing only in the minds of participants. The flights also exist in computer chips and on display screens, on Web pages, and in servers networked through the Internet across the globe. It's as if virtual flights pass through some sort of fifth dimension, a mythic realm also populated by Elvis, the Martian canals, and the Princess of Helium.

So why do people by the tens of thousands indulge in these pursuits? VATSIM controller Mariano Buitrago may be thought to speak for the multitude when he says: "It's a great mental exercise. It allows me to live my passion for aviation in a safe way, in the comfort of my own home. And believe it or not, it allows me to relieve stress."

Believe it or not. ✈

Founded in 2001, Delta Virtual Airlines is the world's largest virtual airline, with more than 2,500 active pilots flying between more than 300 airports in 57 countries.





U.S. AIR MAIL SERVICE
OTTUMWA NAS STA.
IOWA 52501
12:45 P.M.
AUG. 29
2008
IA27-OTMAIOW ROUTE CAM-35

U.S. AIR MAIL SERVICE
EDGEBURG STA.
IOWA 52536
11:30 A.M.
AUG. 29
2008
IA27-OTMAIOW ROUTE CAM-35

U.S. AIR MAIL SERVICE
OTTUMWA NAS STA.
IOWA 52501
11:30 A.M.
AUG. 29
2008
IA27-OTMAIOW ROUTE CAM-35

You've Got

SQUARE-TAIL STEARMANS, STRAIGHT-WING WACOS, AND HISSO JENNIES TOP THE ROSTER OF ANTIQUE AIRPLANES AT A CAPTIVATING GRASS STRIP IN IOWA. BY JOHN FLEISCHMAN



We message. We yak. We text. We chat. We send our love online, but when was the last time you got a real letter? You know, paper, envelope, canceled stamp? Once there were love letters in bad handwriting, rambling accounts of Uncle Bob's bladder surgery, and pleas for additional funds from penniless sophomores.

Mailplanes

A Curtiss Jenny, de Havilland DH-4, and Boeing 40C stand in formation while a Sikorsky S-39 surveys the annual fly-in at altitude.



Jack Greiner and his 1930s Rhinehart-Rose A-4C Parakeet (top); Stinson SM-6000B, Stearman 4DM Speedmail, Stearman C3B (above, front to back.) A Boeing 40C and, in foreground, de Havilland DH-4M2 rumble over Blakesburg (far right). Bob Taylor (right) started the Antique Aircraft Association in 1953.



I grumble but I am as bad as anyone. I had a perfectly good chance late last August to write you a letter from the Iowa City airport, where I'd just dropped by in a 1927 Ford Tri-motor. We'd come to deliver the airmail to Iowa City from the town of Blakesburg, 75 miles to the southwest. The occasion was the 90th anniversary of the U.S. Air Mail Service.

I say "we," although I was only a passenger (seated in a wicker armchair bolted to the floor) and the guest of Greg Herrick, the owner and restorer of the Tri-motor. Herrick had been sworn in that morning by Susan Pierson, the Blakesburg postmistress, as a contract "pilot mail messenger." Herrick, his copilot Nathan Rounds, and a dozen or so other fliers who would be flying the mail that day repeated the oath to "pay over any money belonging to the United States which may come into my possession or control."

Suddenly we were on government business, taking oaths and mailbags at the Antique Airfield, just outside Blakesburg.



It is home to a five-day fly-in that features some of the nation's finest privately owned vintage aircraft and some of the rarest as well.

Today's motley squadron was a veritable airmail museum. We had Frank Schelling's Curtiss JN-4H Jenny, trucked in from the Schellville Airport in Sonoma, California. The Jenny represented the first government airmail aircraft, which took off from a polo field in Washington, D.C. on May 15, 1918, carrying a letter handed over by President Woodrow Wilson. The Jenny was bound for a relay field in Philadelphia and a second jump to Long Island, New York. Unfortunately, the inexperienced Army pilot promptly got lost and, descending to ask directions, cracked up in a farmer's field in Maryland 24 miles away. President Wilson's letter quietly reached New York by train late that night.



For the Contract Air Mail (CAM) era that came in with airmail privatization in 1925, we had a Boeing 40C, a single-engine monster biplane with impeccable airmail credentials. Flying the CAM 8 route between Seattle and Los Angeles, it crashed on an Oregon mountaintop in 1928, an accident that killed its passenger, severely injured the pilot, and scattered its mail to the winds. Eighty years later, Spokane aircraft resurrectionist Addison Pemberton had reassembled the pieces into the only flying Boeing 40C and flown it to Blakesburg to reenact the original transcontinental airmail route. (For a photographic record of his progress across the country last September, visit www.airspacemag.com/specialsections/airmail-odyssey.html.)

At any moment, we were expecting a de Havilland DH-4, the ex-Army bomber that served as airmail's workhorse for a decade. Our DH-4M2 had been forced down en route from its home base at Al Stix' Historic Aircraft Restoration Museum near St.

Louis, Missouri, by a historically appropriate ignition problem. Problem solved, pilot and restorer Glenn Peck would chug into Blakesburg later in the day, with the V-12 Liberty engine sounding, as Peck put it, "like a Peterbilt tractor heading down the highway." Greg Herrick's Ford Tri-motor (and another Herrick-owned tri-motor, a 1931 high-wing Stinson in American Airlines livery) represented the beginnings of the airline era, when CAM contracts were used to support the spread of passenger service. Filling out our airmail heritage were various small contract haulers: a Stearman 4DM Speedmail, a Waco ASO, and even a Sikorsky S-39 flying boat. Today we would all fly to Ottumwa, Iowa, where the Jenny, the Boeing 40C, and those with other plans would turn back. Five of us, including Herrick's Ford Tri-motor, would go all the way to Iowa City.

Postmistress Pierson handed out United States Postal Service canvas bags, one per aircraft. As Tri-motor crew, I helped

stow our scrawny sack in the Ford's baggage compartment.

Our air armada was carrying commemorative "covers," blank envelopes with colorful pictures and imprints made by a rubber "cachet" to mark the occasion, making them suitable for collectors. The covers were also suitable for real letters, as we discovered in Iowa City, where postmaster Doug Curtiss and two clerks had set up an office at the airport. Their job was to "back stamp" the covers: mark them as officially received so we could fly them back to Blakesburg. But Curtiss had his own supply of 90th anniversary airmail covers for sale, plus first-class postage at 42 cents. There were no airmail stamps—there has not been a domestic airmail class since 1977, when the Postal Service said that most first-class mail was flying, airmail stamp or not. Today, the USPS flies 316 million pieces of first-class mail a day, mostly on the aircraft of Federal Express, the postal service's biggest air contractor. Personal letters, or what the postal service calls household-to-household correspondence, make up less than one percent of first-class mail.

I meant to write a letter, honest. But our time in Iowa City was limited, and I calculated the Tri-motor would need an hour for the return flight. The Ford 4-AT-B is authentic right down to the 1927 toilet with authentic direct-to-the-outside discharge. The Iowa City airport offered less daunting facilities.

If I had written, I would have told you that it was exhilarating to fly at 1,500 feet over Iowa's golden ocean of corn, watching the Tri-motor's big shadow skim the green waves below. I would have filled you in about Blakesburg, which is short for

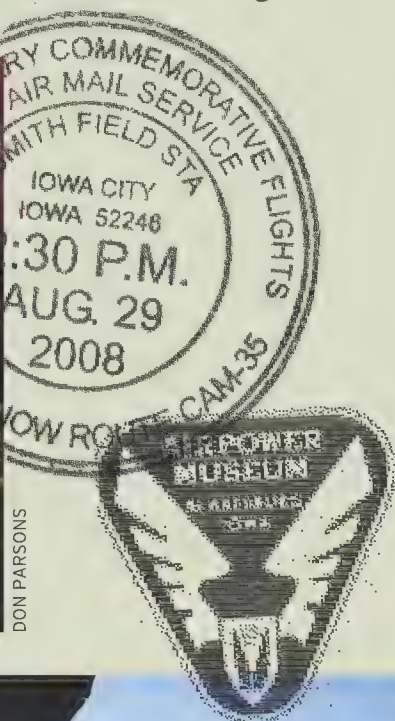
the annual meeting of the Antique Aircraft Association and its associated Air Power Museum. Bob Taylor started the association in August 1953 with a \$12 classified ad in an aviation magazine. "I got 12 members at a dollar apiece, so I broke even," Taylor recalls. "It's been about the same ever since."

The first fly-in, held in 1954 at the Ottumwa airport where Taylor was the operator, attracted five aircraft. The fly-in has been at Blakesburg since 1971, after Taylor bought a 147-acre farm, filled in a ravine to create a 2,200-foot grass strip, and threw up a row of hangars. The 2008 gathering drew more than 325 aircraft and about 1,600 members.

The Blakesburg fly-in is not an airshow. Blakesburg is a meeting for AAA/APM members only, Taylor says, because airshows are a pain in the neck. They draw people who know nothing about airplane safety or etiquette, people who walk into off-limits areas and into spinning props.

Blakesburg is the Un-Oshkosh. (As airplane fans know, Oshkosh is short for the Experimental Aircraft Association's annual Wisconsin fly-in, which last summer drew 540,000 attendees and 10,000 aircraft.) Blakesburg is low-key and intimate. If you don't know most of the Blakesburg crowd by the end of the weekend, they'll probably know you, at least by sight. In fact, Blakesburg is not open to the public. To attend, you'll need to pay \$35 to join AAA/AMP as an associate member.

Local caterers serve home-cooked food in industrial quantities. A lively aerial flea market offers ancient altimeters, retro aviator shades, and conversational scraps like "I wanted to give



GILLES AULIARD



A visitor dodges the sun in a Stinson Tri-motor (top, left). Fly-in attendees watch airplane movies at night (top, right). Above, a Curtiss JN-4H carries the 2008 airmail. Opposite: A Ford Tri-motor (top) and Waco ASO reflect the setting sun. The association's motto (right) spurs pilots onward and upward.



him my propeller, but no, he went out and spent two grand on a new one." Ride offers came at me from every side, including from one gentleman who, after explaining, panel by panel, how he'd assembled his retro acrobatic kitplane, offered me the keys to take it up solo. (Unlicensed, I declined.) At night, old aviation movies aired in the museum hangar. Saturday night was 1932's *Air Mail*, with Pat O'Brien and Ralph Bellamy.

The U.S. Air Mail Service was the orphan child of technology, politics, and patronage. Otto Praeger was the Washington correspondent for the *Dallas Morning News* in 1914 when Postmaster General Albert Burleson, an old friend, Texas hunting buddy, and fellow Democrat, named him postmaster of Washington, D.C. The next year, Burleson named Praeger his Second Assistant and mandated the newsman to modernize all post office transport. Even consider airplanes, Burleson said.

The idea of flying the mail had been around since the hot-air balloon (during the 1870 German siege of Paris, Parisians sporadically flew mail across German lines with balloons). But it was the bona fide airplane and America's 1917 entry into the Great War that gave the Post Office big ideas. With Burleson's support, Praeger pushed airmail past a Congress leery of the cost. When the 1920 elections sent a solidly Republican House and President-Elect Warren Harding to Washington to cut the size of government, the airmail service looked especially vulnerable. Praeger was now a patronage lame duck, but in February 1921 he ordered a last-ditch demonstration of a coast-to-coast, day-and-night relay. Jack Knight carried the eastbound mail by night from North Platte, Nebraska, to Omaha, where bad weather convinced the next pilot it would be suicide to try for Chicago. Volunteering for a second relay, Knight climbed back into the cockpit and flew on to drop out of the soup near a Chicago airport. The final transit time for getting the mail

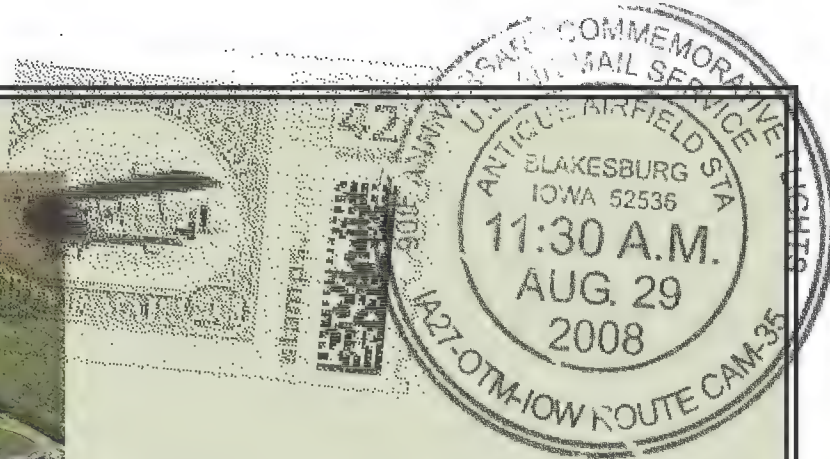
from San Francisco to New York was 33 hours and 21 minutes, 75 hours less than the best train time. That kind of time savings suddenly made economic sense to business customers. Congress was sufficiently impressed to keep the U.S. airmail going until commercial air carriers could build the capital and experience to take over CAM routes.

The U.S. Air Mail Service is usually depicted as a black comedy of regular crashes, occasional deaths, and steady red ink. William M. Leary, author of *Aerial Pioneers*, says that during the Air Mail Service years, 34 pilots were killed. Leary also calculated that in the government-run era, the service cost \$14.4 million and, when revenues and remaining assets are subtracted, it still lost between \$10 million and \$12 million. But the Air Mail Service left a national airway system, connecting the coasts with a route lit by beacons for night flying. It virtually invented cross-country navigation, aerial charting, and systematic aircraft maintenance. To relay real-time weather reports, it set up the first nationwide radio network. It brought the east and west coasts a day closer in business time. Most of all, the Air Mail Service figured out in the 1920s how to transform a bunch of airplanes into a functioning transportation system. Modern commercial aviation is still working out the details.

At Blakesburg, I learned there are two communities devoted to airmail days. The antique airplane fliers were impossible to miss, as they taxied their brightly colored machines on the grass and circled overhead. The other community was keeping watch, as they always do, from far away: the stamp collectors.

Airplane devotees and stamp collectors have been together from the beginning. Indeed, some collectors don't even wait for the Wright brothers: They collect balloon and airship mail. Others pursue only "pioneer" covers, the term for any postmarked letter or card flown as a stunt or a promotion. But real airmail





Antique Airfield (left) was originally farmland, like most of Iowa. Below: Restorer Glenn Peck, on the wing of a DH-4M2, talks shop with Brent Taylor, fly-in chairman and son of founder Bob Taylor. Below left: Vintage visitors include (foreground, from left): Hatz Classic, de Havilland DH-82A, Marquart Charger. Background: Stinson SM2AA, Fairchild 22 C7D, Ryan SCW, Ryan STA.



stamp collecting begins on May 15, 1918, with the real U.S. Air Mail Service and a Jenny JN-4H, which appeared on the first U.S. airmail stamp—eventually the most valuable stamp in U.S. postal history. W.T. Robey, a Washington attorney and collector who bought a sheet of 100 at the post office, realized that the blue airplane had been printed upside down on the red and white stamp. He recalled: “My heart stood still.” The hearts of collectors have stood still ever since. One inverted Jenny, originally 24 cents, sold at auction in 2007 for nearly \$1 million.

And then there are “crash covers.” The American Air Mail Society has offered these since 1923, when in its first catalog it included a section on “Interrupted Flight Covers, familiarly know as Crash Covers”—postmarked envelopes recovered from aircraft that have crashed, caught fire, or otherwise not made the swift completion of their appointed rounds.

Addison Pemberton’s Boeing 40C is listed in the AAMS book under 1928: “October 2. ROSEBURG, OREGON PAT—CAM 8. Pilot Harry G. Donaldson crashed his plane because of fog. Mail carried 22 lbs. A few loose covers salvaged in damaged condition but forwarded without special markings. One cover known.”

For another example, I might have taken a closer look at the DH-4 that flew into Blakesburg from St. Louis in the maroon

and silver livery of Robertson Aircraft Corporation, the outfit that hired Charles Lindbergh to fly an airmail route. Lindbergh crashed two Robertson DH-4s in 1926, bailing out when he was out of fuel. A Lindbergh crash cover from the second wreck, in November 1926, is in the collection of Philip McCarty, a renowned collector of U.S. domestic crash covers. But McCarty says that the community is abuzz with the news that a cover from Lindbergh’s first bailout has surfaced.

McCarty, who has examined the cover, which has markings indicating that it had been delayed by a wreck, says it spent the last 82 years framed on a wall, the prized possession of the man who received it. (Now in the hands of a dealer, the cover could fetch \$6,000 when it comes to auction.) The letter crashed to earth near Ottawa, Illinois, on September 16, 1926, after Lindbergh jumped from his fuel-exhausted DH-4 into fog. As the airplane nosed down, the last ounces of fuel trickled into the carburetor and the engine revived, leaving Lindbergh floating down while listening to his own airplane circling in the fog.

The story was a favorite at Blakesburg. Next year, there will be others. Each night the sun will set into the western corn. When the Pilot’s Pub opens, a boisterous crowd will spill out of the hangar. Off in the dusk, campers will unfold their gear under parked aircraft. Waving a balsa glider and a flashlight, a boy will roar down the wet grass runway. Overhead, a jet-black Iowa sky will be ablaze with stars. ✈

Opposite: The wings of a Bird biplane frame a Stearman 4E (right) and the Boeing 40C (center).

How Things Work:

Ground

BY PETER GARRISON | ILLUSTRATION BY JOHN MACNEILL

"I WAS STANDING RIGHT NEXT TO IT," SAYS FRANK ROBINSON, FOUNDER OF THE WORLD'S LEADING HELICOPTER COMPANY, DESCRIBING A CLOSE CALL HE HAD DURING A 1961 TEST OF A GYROPLANE. "I HAD TO GRAB HOLD OF IT AND HANG ON AND RIDE THE DAMN THING DOWN. YOU DON'T WANT TO BE STANDING OUT THERE WHEN IT STARTS TO JUMP AROUND – IT CAN JUMP ON YOU. AND THERE'S NOT A GOOD WAY TO GET OUT OF IT. JUST CUT EVERYTHING, HANG ON AND HOPE."

What Robinson wrestled with is ground resonance, a demon that has demolished helicopters and killed pilots, passengers, and bystanders. The National Transportation Safety Board records 34 incidents in the United States since 1990, but that does not include military helicopters or incidents that did not injure people or destroy the helicopter.

Not all types of helicopters are susceptible to ground resonance. All those two-blade Robinsons are exempt because their "teetering" rotors are a single rigid structure, like a see-saw. The only rotors that can produce ground resonance are those with three or more blades. Multi-blade rotors have lead-lag hinges,

which allow blades to speed up and slow down at different points as they circle the mast while the helicopter is moving forward. The hinges keep the fluctuating lift and drag forces on each blade from inflicting excessive stresses on the rotor hub. Snubbers and dampers limit the motions of the blades.

Because it is massive and spinning at a high speed, the rotor of a helicopter must be properly balanced. If the lead-lag hinges allow the blades to depart from perfect symmetry, the rotor's center of gravity shifts slightly to one side of the mast, throwing the system out of balance.

Anything that's springy has a favorite frequency of vibration—its natural frequency—which is determined in part by its size and mass. That's why tuning forks always produce a certain tone, and why boats of different sizes rock at different rates. When two things with the same or similar natural frequencies are in contact, or sometimes even merely close to each another, and one of them begins to vibrate, it may "excite" the other to vibrate as well. The ability of one vibrating object to create this sympathetic vibration in another is what enables the rotor blades to gain control of the entire helicopter.

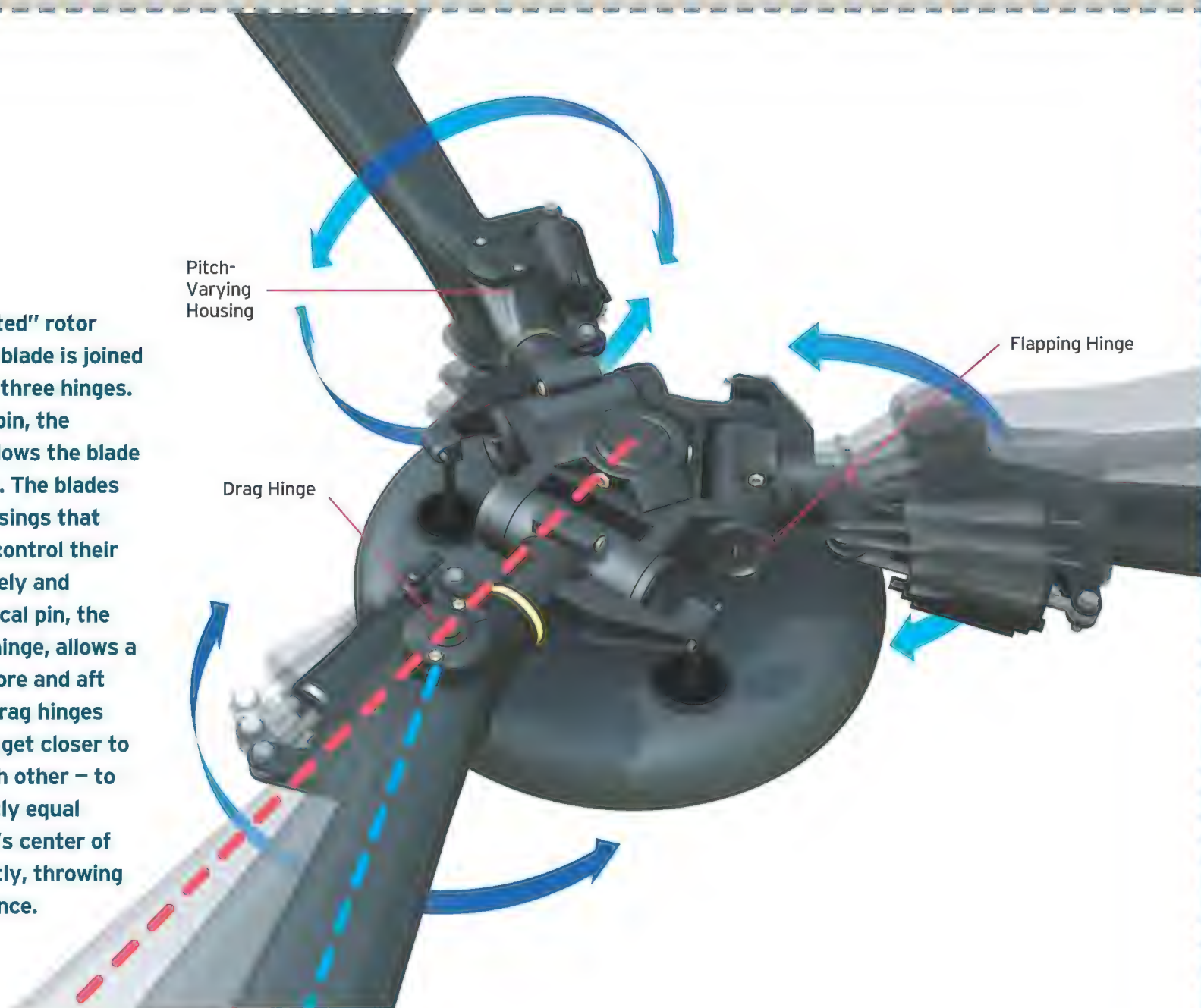
In December 2005, an Aerospatiale Alouette III landing at Escalante National Monument in Utah suffered ground resonance that tore the helicopter apart in four seconds. All aboard survived.



ALICIA TANRATH/ZION NATIONAL PARK

Resonance

On a “fully articulated” rotor system, each rotor blade is joined to the rotor hub by three hinges. A horizontal hinge pin, the “flapping hinge,” allows the blade to flap up and down. The blades are mounted in housings that enable the pilot to control their pitch both collectively and individually. A vertical pin, the lead-lag or “drag” hinge, allows a limited amount of fore and aft motion. When the drag hinges allow two blades to get closer to or farther from each other – to depart from perfectly equal spacing – the rotor’s center of gravity shifts slightly, throwing the disk out of balance.



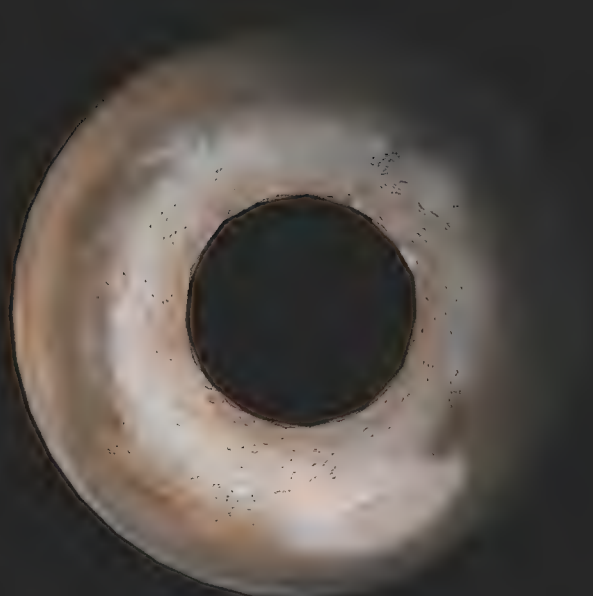
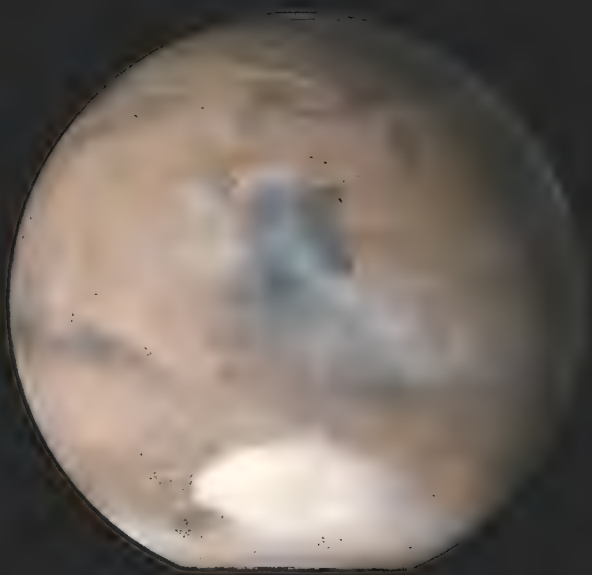
The helicopter’s airframe has its own natural frequency, which can be excited by an out-of-balance rotor. Usually there is a triggering event: a bump or a landing or takeoff on sloping ground or with a little sideways or forward motion. A jolt moves the mast while the blades, because of the freedom of motion allowed by their hinges, lag a little behind. The rotor, now slightly out of balance, begins to wobble like a slowing top. If the characteristic vibration frequency of the airframe is close enough to the rate of rotation of the rotor, it joins the dance, amplifying the rotor wobble.

The destruction is wrought by the considerable energy stored in the rotor blades. The shaking rapidly grows in violence, exceeding the strength of the mast, transmission mounts, and landing gear. The cyclic control in the cockpit flails about so violently that the pilot cannot hold it, the rotor blades strike the tail boom or the cockpit, parts begin falling off, and moments

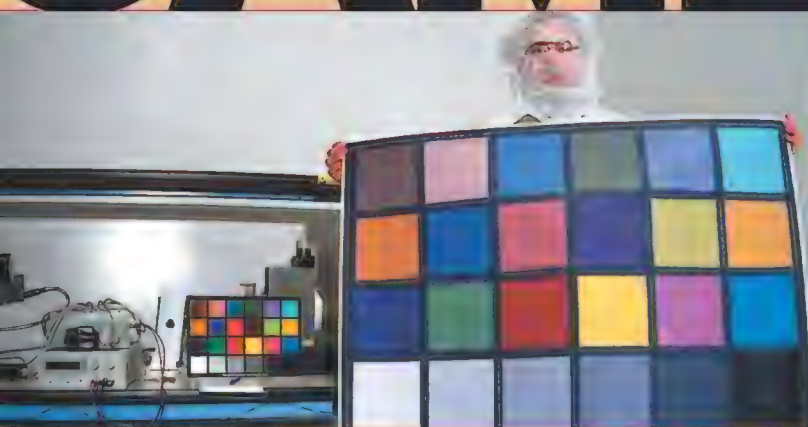
later the helicopter may be a heap of scrap.

If ground resonance begins, the pilot’s best option is to get the helicopter into the air. Once the tires or skids are no longer touching the ground, the vibration fades. If the rotors do not have sufficient speed for flight—or if, as in Robinson’s case, the aircraft is a gyroplane and can not hold itself aloft—the next best remedy is to eliminate lift by reducing blade pitch; shut down the engine; and hope for the best while waiting for the rotor to slow.

The wait-and-hope approach is only sometimes successful, so a better solution to ground resonance is to prevent it. Helicopters with multiple-blade rotors have shock-absorbing landing gear with powerful dampers that allow it to soak up the energy that would otherwise set the helicopter shaking. When ground resonance occurs in these craft, it is usually because tires or shock absorbers have been improperly serviced.



A CAMERAMAN ON MARS



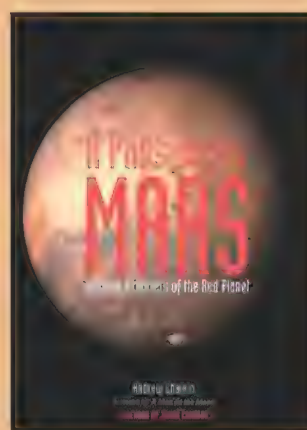
IF YOU REALLY WANT TO KNOW THE PLANET, FLIP THROUGH MIKE MALIN'S PHOTO ALBUM. **BY ANDREW CHAIKIN**

IN 1958, WHEN EIGHT-YEAR-OLD Michael Malin was taking trombone lessons, he was informed by his teacher that he would never amount to anything. The boy reacted by practicing three hours a day, seven days a week, until 10 years later, as a high school senior, he was accepted at New York's prestigious Juilliard School of Music. He turned down Juilliard to study physics at the University of California at Berkeley. "Music was never my career," Malin explained many years later. "Science was my career." Still, the obsessive persistence remained. "If you ever want Mike to do something," fellow Mars scientist Phil Christensen once said, "tell him it can't be done."

The one thing Malin had known he wanted to do, since early in his southern California childhood, was space explo-

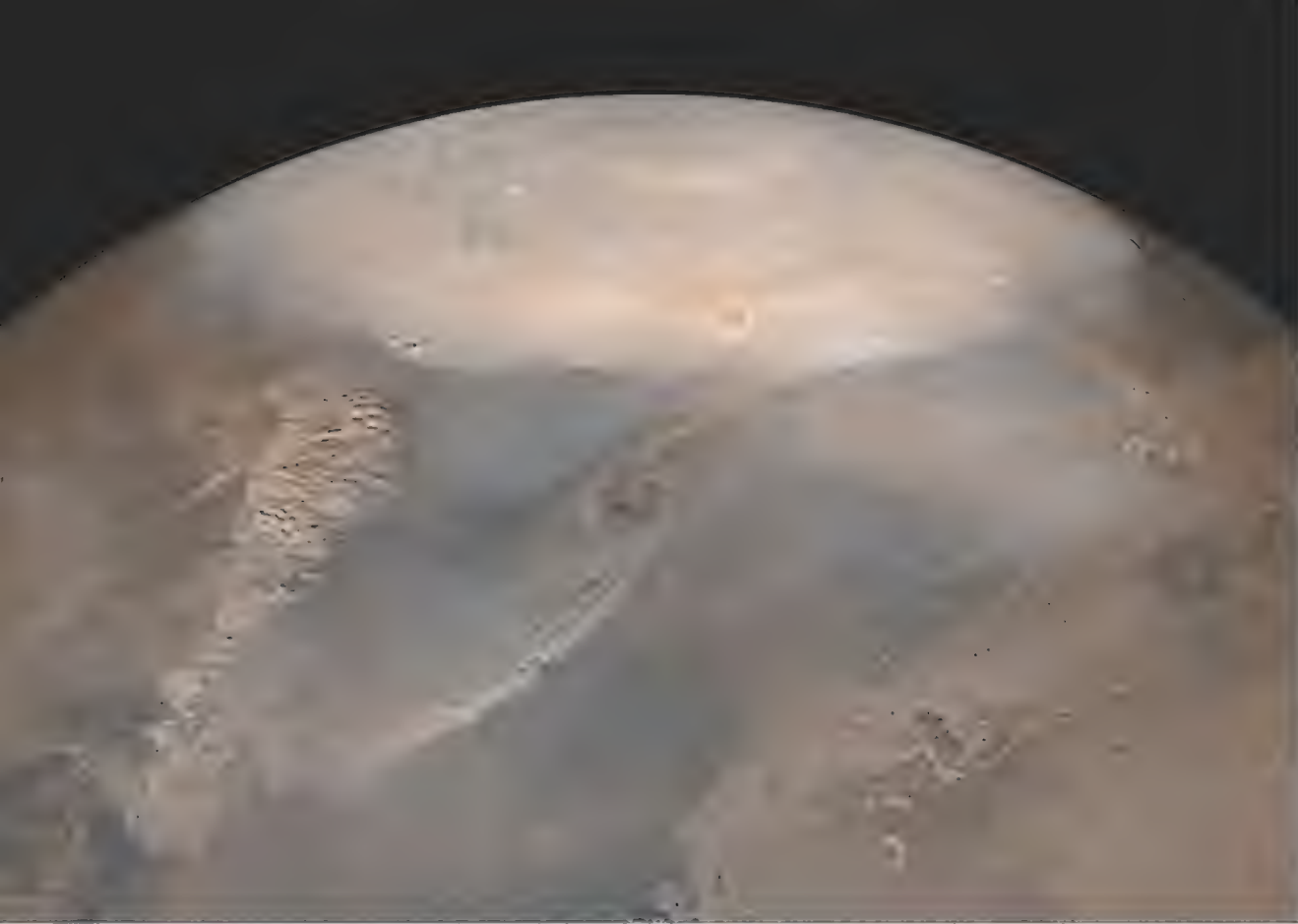
ration. He'd gone to Berkeley thinking he would be an astrophysicist, but when he saw that some of his professors were studying the first lunar samples, he became captivated by planetary geology. Malin went on to grad school at the California Institute of Technology; his thesis advisor there, Bruce Murray, was a member of the imaging team for Mariner 9, the first spacecraft to orbit Mars. At Christmastime of 1971, when a planet-wide dust storm was clearing and Mariner's cameras began to reveal a geologic wonderland, Malin was at NASA's Jet Propulsion Laboratory, seeing each new image as it came in.

I first met him several years later, during the Viking Mars missions, when he was fresh out of grad school and working at JPL. Compact and intense, his dark eyes framed by horn-rimmed glasses, Malin had a penetrating intelligence combined with a sort of arrogant exuberance. In some ways he was a collection of opposites. There was delight and disdain in him in equal measure. He could be prickly, but laughed easily and loved a good joke. He was both imperious and generous. His interests were those of a Renais-



Excerpted and abridged from A Passion for Mars: Intrepid Explorers of the Red Planet, by Andrew Chaikin, published by Abrams, October 2008.

Opposite: Six views of Mars, each assembled from about two dozen frames taken by the Mars Observer Camera. Above: During ground tests in a clean room last July, Mike Malin holds a color chart used to calibrate one of his Mars-bound cameras.



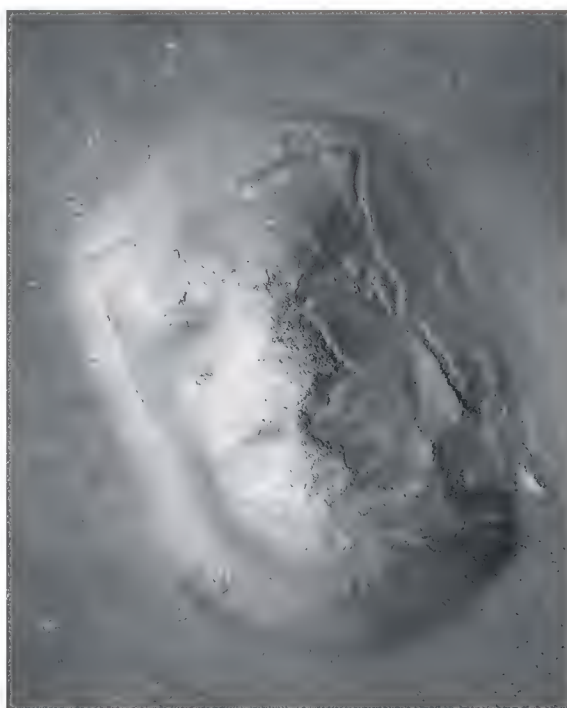
of scientists, engineers, and even some Caltech undergrads. One member of the team was a young computer ace named Tom Soulanille, who had designed video games under contract to Mattel and, barefoot in cut-off jeans and thrift-shop T-shirts, looked the part of the hacker. With Danielson providing a softspoken voice of experience to keep the young and energetic wizards on track, Malin and his team

Left: A mosaic of MOC frames showing the planet's polar ice cap. Below: The famous "Face on Mars" (left) was revealed by MOC to be an ordinary rock formation. But a different Malin-built camera – on the Mars Reconnaissance Orbiter – found another face to take its place.

sance man—he'd even minored in English at Berkeley—but he brought a laser-like concentration to whatever he was working on. (Years later, Malin would cite focus, rather than intellect, as his strength.) By his own admission he could be brusque and difficult to work for; he also had an elephant's memory for the slights and injustices he'd sustained. Like many very smart people, he could be frustrated at others' inability to see things that to him were clearly evident.

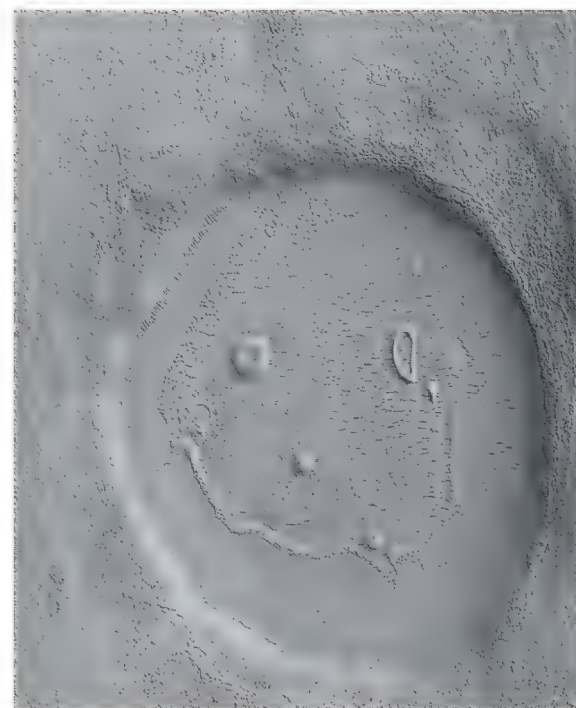
After Viking, with no NASA Mars missions under way, Malin increasingly found his attention drawn back to Earth. As a specialist in the geologic discipline called geomorphology, he was trained to deduce the history of a place by analyzing its landforms. So he journeyed to places that could help him understand Mars. He ventured to the slopes of lofty volcanoes, including Hawaii's Mauna Loa and Washington State's Mount St. Helens, which he visited less than a month after its 1980 catastrophic explosion. He went to Iceland, where volcanic heat has mingled with glacial ice. He studied the processes of erosion—by water, in the deserts of Utah and Arizona, and by wind, in the dry valleys of Antarctica. And the more he saw, the more he came to believe that the existing views of Mars, from Mariner 9, the Viking orbiters, and the Viking landers, would never tell the whole story.

So in 1984, with NASA planning its first Martian orbiter in years, Malin proposed a camera to capture the unseen Mars lurking in the resolution gap between previous pictures taken from orbit and those



taken on the surface. His colleagues promptly rejected the idea, fearing that even a small camera would be too costly, not just in terms of money but in weight, power requirements, and data transmission needs. "They didn't want a camera," Malin said. "There was no need to fly a camera. Viking had already taken all the pictures we ever needed of Mars. I, of course, felt that was absurd." Until geologists were working on Mars, he believed, pictures would remain the key to unraveling the planet's mysteries. And the only way to get the pictures he wanted was to write the specs for the camera himself.

First, he sought out Ed Danielson of Caltech, who had been helping to design cameras for planetary exploration since Mariner 9. With Danielson's help Malin put together a small and, in the words of one engineer, "wonderfully unruly" group



NASA/JPL/MALIN SPACE SCIENCE SYSTEMS (3)

came up with a groundbreaking design.

For reliability, the camera would have no moving parts, not even a shutter (Malin was mindful of Danielson's stories of past mishaps, like the stuck filter wheel that robbed Mariner 9 of the ability to take color pictures for most of its mission). Among the leading-edge technologies chosen for the design was a type of electronic light sensor called a charge-coupled device, which had only recently become available for space missions. In particular, Malin's team zeroed in on the idea of using a single line of CCD detectors—similar to that in a fax machine—to produce a single line of an image. To build up successive lines, they would use the motion of the orbiting spacecraft, rather than turn the array. In this so-called push-broom design, the camera could take pictures covering a swath of Martian

ground about two miles wide and up to 10 miles long.

Coupled to a 14-inch-diameter telescope, the camera would snare targets about three meters (10 feet) across—sharp enough, Malin hoped, to show large boulders, or even the Viking landers on the surface. His team had come up with a camera powerful enough to see the hidden Mars, yet small enough and light enough to have only minimal impact on the Mars Observer mission.

But some scientists still resisted. NASA was well aware of the resistance; one high-ranking official told Malin his camera would go to Mars “over my dead body.” And that would have been the end of it, if not for a last-minute intervention by

NASA’s associate administrator for space science, Burt Edelson. In early 1986, when Edelson sat down to review the final instrument selection for the new Mars orbiter, he was surprised to see no mention of a camera, and even more surprised to hear that the scientists didn’t want one. Edelson told his chief scientist, “I’m not going to approve of any mission to Mars, or any planet, that doesn’t have a camera onboard.... Go back and put a camera on it.” And so Malin’s team got their ticket to Mars. In September 1992, after six years of 70- to 80-hour weeks struggling to meet the launch window, the Mars Observer Camera—MOC for short—left Earth atop a Titan rocket.

By that time, Malin had left his faculty position at Arizona State University and, using money from a 1987 MacArthur Foundation “genius” grant, formed a company near San Diego called Malin Space Science Systems, where he would lead the operation of the camera and the analysis of its images. Visiting Malin in his office, I could hear the complex emotions of what had become a very personal ef-

fort. “I think of MOC as my eye,” he told me. “Nothing like this camera has ever flown. I hope it works.” Malin was experiencing the potent mix of apprehension and exhilaration that comes with building instruments for other worlds, and he loved it. “This is incredibly addictive,” he said, as his creation headed for a glowing orange dot in the San Diego evening sky. “I’m on my way to Mars!”

The journey turned out to be longer than anyone anticipated.

In August 1993, just before going into orbit around the planet, Mars Observer fell silent; a review board later concluded that the craft had likely been crippled by a fuel line rupture. After the loss of the \$800 million probe, NASA administrator Dan Goldin adopted his “Faster, Better, Cheaper” approach to space missions, among them a new, less expensive Mars orbiter called Mars Global Surveyor. When it headed for Mars in November 1996, Global Surveyor carried the backup hardware for Malin’s lost camera. On September 11, 1997, more than a decade after Malin first proposed it, MOC arrived safely in Martian orbit.

A FEW WEEKS LATER, Malin got a visit from Bruce Murray, who wanted to see what his former student was up to. It had been more than 30 years since Murray and his teammates had endured an eight-hour wait for every one of Mariner 4’s low-resolution pictures, the first close-ups ever taken of the Red Planet. Now several MOC images, each offering a level of detail unimagined in 1965, were streaming from Mars to Malin’s offices every day. For Malin, Murray’s visit was more than just a social call; it was a passing of the torch. “It was incredibly rewarding,” Malin recalled years later. “Bruce was like Obi-Wan and I was Luke Skywalker, and now I was the master.” While Murray and Malin were talking, another image came in, and Malin brought it up on the computer monitor. The image covered part of Tithonium Chasma, a giant rift near the western end of the complex of canyons known as Valles Marineris. It was late afternoon on that part of Mars, and the floor of the canyon was in shadow, but the canyon walls were beautifully lit.

Together, Malin and his former mentor combed the sunlit slopes for detail, until they came to a triangular patch of



NASA/JPL/MALIN SPACE SCIENCE SYSTEMS

Patterns of circular depressions and irregular mesas near the Martian south pole – dubbed “Swiss cheese” by scientists – had never been seen on any planet. Below: Malin with the prototype of one of his cameras in 1999. The flight version was lost on the ill-fated Mars Polar Lander later that year.



ANDREW CHAIKIN

exposed rock, more than 3,000 feet high, that stopped them in their tracks. Within that bright triangle they could see dozens of dark, closely spaced horizontal lines: layers, more numerous and on a finer scale than anyone had suspected exist. Speaking for both of them, Murray uttered an expletive of surprise. In this one image, MOC seemed to reveal that the upper crust of Mars was not what Mariner 9 and Viking had led everyone to expect: It wasn't a rubble pile of impact debris, like the moon's crust. In those layers were hints of an untold Martian history.

Some 17 months later, on March 21, 1999, two images came down—years later Malin could still recite the exact frame numbers—that changed his view of Mars forever. They showed part of the floor of Candor Chasma, one of the Valles Marineris canyons. When he saw them, Malin was speechless with amazement: The canyon floor was covered with eroded mesas of spectacularly layered sedimentary rock.

It was the uniform thickness of the layers, the repetitive sequences of rock types, that was so remarkable; on Earth, these

were the kinds of layers produced in standing water. You couldn't rule out some other process—perhaps the layers were made of dust laid down in an ancient, cyclically varying Martian atmosphere and later cemented into rock—but the more Malin looked at the new images of Candor Chasma, the more certain he felt he was seeing sediments that had been deposited in a lake or shallow sea. MOC was letting him look back on an ancient, watery Mars, and the view was spellbinding.

Nearly every place where MOC photographed Martian bedrock—on the walls of craters and channels, on the slopes of buttes and mesas—it revealed more layers. In the ancient cratered highlands, thought to be the oldest terrains on the planet, MOC showed him that the earliest chapters of Martian history were far more complex than anyone had thought. Throughout the ancient crust, interleaved with giant impact craters, were layers of sedimentary rock. They seemed to say that even as the young planet Mars was pummeled by asteroids and comets, the battered landscape had been dotted by lakes, sand dunes, and drifts of wind-blown dust.

By this time, Malin had taken on a partner, a 33-year-old geologist named Ken Edgett, who had gone to grad school at

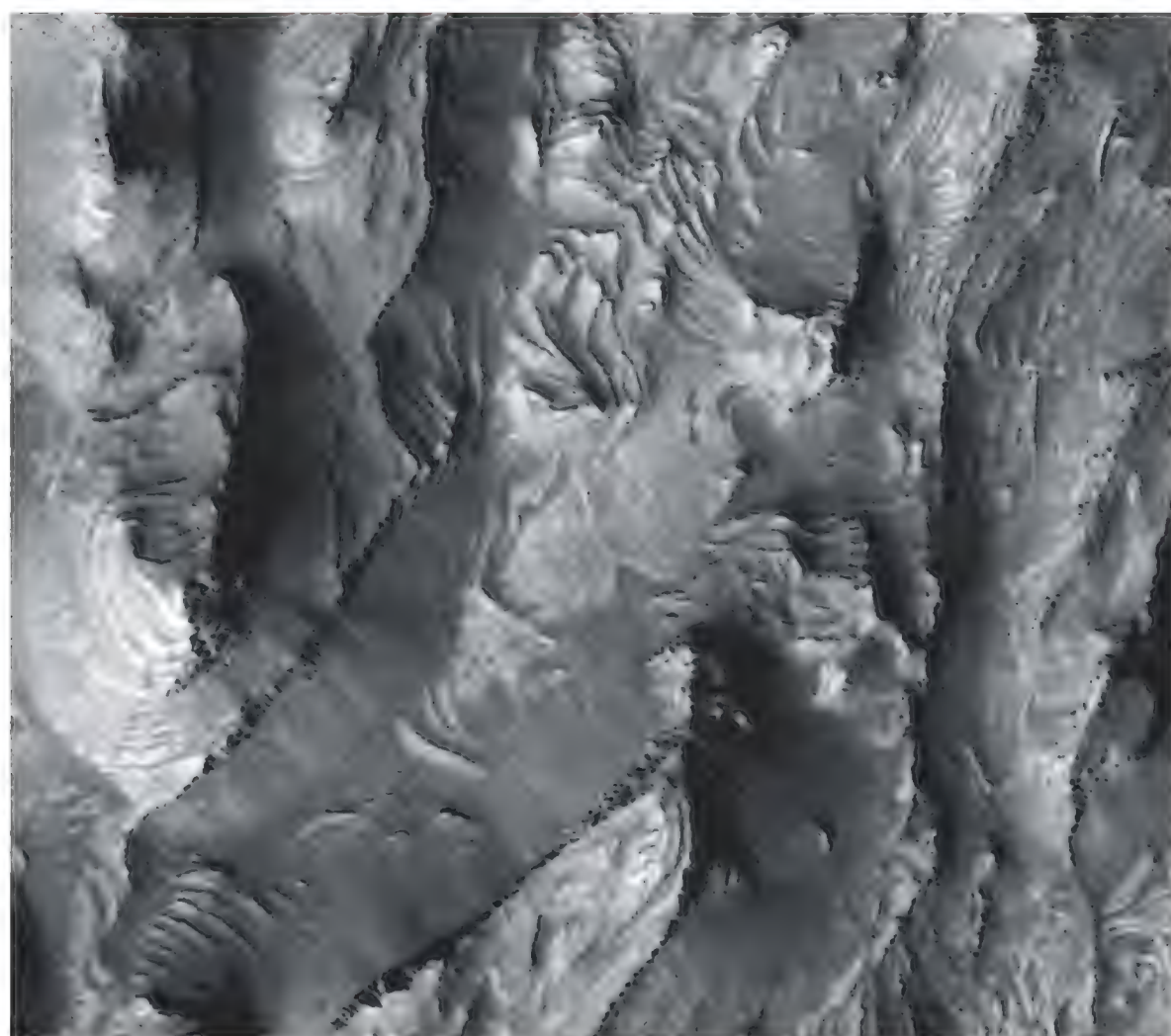
Arizona State, where Malin was one of his professors. In temperament, at least, the two geologists were an unlikely pair; one ASU classmate called Edgett a “huggy bear.” But they shared a passion for Mars, and Malin recognized his younger colleague's skills as a scientist. By the summer of 1998 Edgett was given the important role of choosing most of the camera's targets. Each day he combed the planet-wide mosaics of old Viking images for the most important places on which to train MOC's powerful eye. There was a long list of features, from valley networks to polar layers, that had been known since Mariner and Viking, all of which were ripe targets.

But there was so much that *wasn't* in the Viking images, or any other previous views, like the strange, twisted rock layers on the floor of the giant Hellas basin, which resembled pulled taffy. And the bizarre texture of the south polar ice cap, which was riddled with circular pits that made it look like a slice of Swiss cheese. And the fact that places that looked smooth in the old Viking images were revealed as astonishingly rough by MOC, while rough terrain seen by Viking often looked smooth at higher resolution.

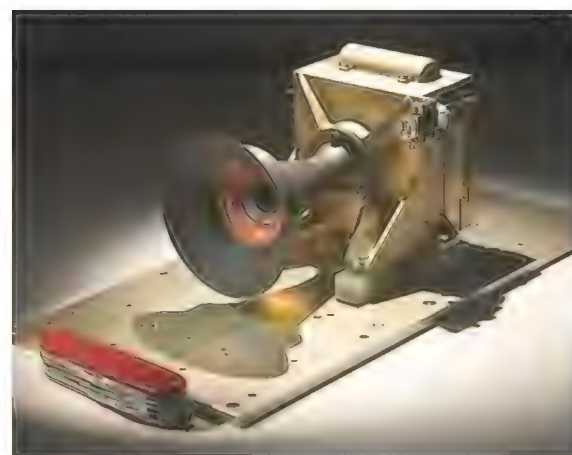
Mike Carr, who led the team that had acquired the Viking Orbiter images 20 years earlier, came to San Diego to spend a week targeting MOC with Edgett and Malin. Carr had spent as much time studying Mars as any human being, but the planet revealed by MOC was entirely puzzling to him. Sometimes, as he walked the halls of Malin Space Science Systems, his head buzzing with profound and unsettling questions, he could be heard muttering in his mild Yorkshire accent, “We just don't *understand* this! It just isn't the Mars we understood! *I don't get it!*”

EVEN AFTER a couple of years in San Diego, Ken Edgett was still vague in finding his way around the neighborhood he lived and worked in. But when it came to navigating MOC's Mars, he was absolutely masterful. “He knows Mars better than any other person on the planet,” says Malin. “Way better than me.” Edgett spent almost every waking hour in front of the computer screen in his office, stopping only for fast food from a nearby mall. It got to the point where he could glance at any one of the tens of thousands of im-

Window on a watery past: Layered sedimentary rock covers the floor of Candor Chasma, a Martian canyon.



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A crater wall photographed by MOC shows gullies that hint at recent water flow. Above: This diminutive camera flew on the 2008 Mars Phoenix lander.


ages MOC had received and be able to say, aided only by the image ID number, where it had been taken. One of the scientists on Malin's staff who had helped to develop MOC, a geologist named Mike Ravine, had warned Edgett to pace himself, saying that this mission would be a marathon, not a sprint. But Edgett couldn't help himself. "It was too cool to peel yourself away," he said.

And during 1999 the pace of work was absolutely relentless. Each day brought a flood of new images, sometimes as many as 300, to look at. Sometimes he was so busy preparing for the next batch of pictures to be taken that he barely had time to study the ones that had just come in. Every new image had to be submitted to NASA's archive of planetary data and posted on the Internet within six months af-

ter it was received. And on top of everything else, he and Malin were given the added task of photographing landing sites for the upcoming Mars Polar Lander mission; after it crashed in December 1999 they used MOC to search—in vain—for the wreckage.

No wonder, then, that they'd had no time to publish their discoveries in scientific journals. But by the spring of 2000, things had slowed a bit, giving the pair time to write a paper for *Science* magazine on a discovery that, to Edgett, was the most surprising so far: thousands of features that looked like drainage gullies on the walls of craters, cliffs, and valleys. Each gully had a narrow channel running down the center, and that meant the gullies had to have been carved by a fluid. The only fluid that made any sense was liquid wa-

ter. The really troubling thing, though, was that these features weren't relics from some ancient, wetter epoch; they were so fresh that they had to be geologically recent. In fact, Malin later said, "we cannot rule out that some of them are so recent as to have formed yesterday." But, as everyone knew, Mars was now too cold, and its atmosphere too thin, to allow liquid water to exist. Or was it? Water was the one explanation Malin wanted to avoid, because it went against everything he thought he knew about present-day Mars. But Malin and Edgett ultimately concluded it was the only explanation that made sense. In June, at a packed press conference at NASA headquarters, they announced evidence that water had flowed on Mars in recent times.

That revelation, which stirred both excitement and controversy, was just the beginning. At the end of 2000 they published their discoveries of the complex, layered nature of the upper crust of Mars. Then there was the finding, made public in late 2001 and early 2002, that the mysterious pits in the south polar ice were actually getting bigger, evidence that this supposedly permanent mantle of frozen carbon dioxide was actually disappearing while we watched. "What this tells you," Malin said in 2004, "is that Mars is experiencing today global warming." MOC's Mars is a world in transition, nothing like the changeless fossil it was once thought to be. For Bruce Murray, the planet revealed by his former student's camera is so surprising that he now calls Mars "the land of broken paradigms." And Mike Malin, who says Mars is "a puzzle with most of the pieces missing," still feels humbled in the face of its mysteries. 

One More Second

THE MASTERS OF TIME ARE ABOUT TO GIVE US A LITTLE EXTRA. USE IT WISELY.

BY JAMES R. CHILES

AS THE CALENDAR TURNS from 2008 to 2009, clocks around the world will stutter. Their timekeepers have been instructed by an international committee to add what is called a “leap second” to official time. Timekeepers in Greenwich, England, the location of a world time standard since the reign of Queen Victoria, will tuck the second in just ahead of midnight. The leap second will show up on U.S. East Coast clocks five hours before the big ball drops in Times Square. In Tokyo, revelers will be sleeping off their celebration when the extra second arrives just before the stroke of 8 a.m. on January 1. The leap-second insertion may be the only human event that occurs simultaneously worldwide.

Why do we need it?

Earth’s rotation is slowing. We like to think our planet takes a dependable 24 hours for a single spin, but ocean tides force Earth to give up a bit of its rotational energy. Since 1972, Earth’s loss of oomph has prompted international groups in charge of global reference systems—currently, the International Earth Rotation Service—to ask timekeepers on 23 occasions to add leap seconds onto a broadcast global time standard with the French acronym UTC, for Universal Coordinated Time. (No, 1972 isn’t the first year the Earth became sluggish; our home planet has been slowing down for eons. Earth went around so much faster in the Pale-

ozoic era that a day then was about two hours shorter than a day in 2008.) The seconds have been added to keep Universal Coordinated Time synchronized with the apparent movement of the sun in the sky.

Universal Coordinated Time is a relatively modern system, based on a scale far more stable and predictable than even that offered by planetary motion. (Earth’s spin is an imperfect timekeeper, but it’s no slouch. Over the past 200 years, the length of the day has increased by only 0.0025 second.) UTC is counted by cycles in the frequency of microwaves emitted by an isotope of cesium. Its basic unit, the second—defined in 1967 and one of seven standard units presided over by the International Bureau of Weights and Measures in Sevres, France—is the duration of 9,192,631,770 cycles, or hertz, of that specific energy. The atomic clocks that measure the frequency are the most accurate scientific instruments in existence. They will neither lose nor gain a second over hundreds of millions of years.

According to Peter Whibberley, Senior Research Scientist for Time and Frequency at the British National Physical Laboratory, the clocks were created not because their inventors felt the need to mark time more precisely, but “to keep track of the variation in the Earth’s rotation.” Astronomers have long known that they couldn’t really set their watches by Earth. From timing the lunar eclipses of certain



stars, they learned Earth’s rate of rotation was changeable.

The forces that may speed or slow Earth include seasonal effects on oceans and winds, the swirlings of molten metal deep in the core, a tightening of the middle latitudes that is making the planet slightly rounder than before, and thinning of glaciers caused by global warming. It comes down to conservation of angular mo-

mentum. Think of a skater doing a pirouette with her arms flung out: whenever she pulls her arms in, her spin rate must go up, to conserve the angular momentum. If Earth's densest molten rock settles closer to the core, all of us Earth-riders speed up—a little. This may sometimes



PHOTO-ILLUSTRATION TED LOPEZ/BRANDXPICTURES

counter the tidal action slowing us down. For reasons not yet clear, reports Richard Gross, a geophysicist at NASA's Jet Propulsion Laboratory in California, Earth ran unusually slow for a few months in 1912, making for the longest days in the 20th century. By contrast, on July 13, 2003, the Earth was speedy enough that it beat the clock by one millisecond, going around in 86,399.999 seconds flat. Still, on average the days of our lives must get longer.

But no expert or computer can predict when forces will combine to slow Earth so much that we need another second again. Although leap seconds have generally been added every year or two, Earth had something unusual going on in its core during a six-year stretch after the New Year's of 1999. During that period, timekeepers required only one leap second to keep the accounts straight.

How does anybody know that a given day in 2003 took a millisecond less than the standard day? The answer comes from radio antennas spaced on continents around the world, portrayed lovingly but erroneously in the Jodie Foster movie *Contact*. Together they make up the Very Large Baseline Interferometry, or VLBI, network. Magic with signal processing and precision timing turn the global network into one giant antenna, thousands of miles in diameter. That size gives it very sharp vision in the radio spectrum.

The VLBI network was set up to plumb the depths of the distant universe, the farthest objects of which are quasars, giant galactic cores that blast radio waves and X-rays across billions of light years. Because they are so far away, quasars appear to receivers on Earth almost stationary, so astronomers use them as a fixed frame of reference. Using radio antennas to pick up signals from quasars, scientists can

Earth to help spacecraft navigate around the solar system. That's why the lab has a geophysicist—Richard Gross—among its astrophysicists.

Because Earth's movements are so unpredictable, atomic clockmakers can't helpfully pre-program leap seconds into new clocks. Nobody knows about the next one more than six months in advance.

What timekeepers do know is that the number and frequency of leap seconds required can only increase. "My guess is that we may need more than one in five or 10 years," says Bill Klepczynski, the former director of time at the U.S. Naval Observatory, "but nobody knows for sure." The growing complexity of electrical transmission, broadcast, Internet, and telephone systems, all of which rely on precise synchronization, makes frequent insertions risky. The 2005 leap second revealed a programming problem at the Swiss time-broadcasting station HBG, and some "network time protocol" servers on the Internet suffered computer hiccups. Such dangers have prompted several scientific organizations, including the U.S. Naval Observatory, to recommend that leap seconds be discontinued.

Others believe that leap seconds should no longer be inserted in the broadcast time scale, to which society's sensitive machines are tuned, but should contin-

The growing complexity of broadcast, Internet, and telephone systems, which rely on precise synchronization, makes frequent insertions risky.

monitor the rotation of Earth with great precision.

Here's how they do it: Using atomic clocks, geodetic researchers measure the slight time differences between the arrival of a quasar's signals at several widely separated radio telescopes. The delays in arrival times change as the Earth rotates. Knowing the fixed positions of the telescopes and the changes in the time differences makes it possible to calculate the rate of the Earth's rotation.

The Jet Propulsion Laboratory needs to keep a close eye on Earth's rotation because it uses tracking measurements taken by telescopes located on the rotating

ue to be inserted in global civil time. Observatories, which rely on UTC when steering automated telescopes, have joined to fight off a proposal from anti-leap-seconders to drop the leap second and make a change only every 600 to 900 years, by inserting a full hour instead. "Civil time that tracks the sun means that we keep a conventional meaning of time that is consistent with all of human history," argues researcher Steve Allen of the University of California's Lick Observatory. In any case international discussions about changing time take lots of time, so leap seconds are in our future through 2019 and probably longer. —

THE BLACK EAGLE OF HARLEM



IN 1930, WHEN FUTURE ETHIOPIAN ruler Haile Selassie was planning a lavish ceremony to celebrate his coronation as emperor, he sent an emissary to a 33-year-old U.S.-based aviator, Hubert Fauntleroy Julian. Aviation had come to Ethiopia only the year before, with the arrival of a French Potez 25 biplane piloted by André Maillet, but the modernity-obsessed Selassie hoped to put on an aerial display, with a flamboyant performer who would attract the world's attention. Julian, known in New York as the "Black Eagle of Harlem" and sometimes called the "Negro Lindbergh," was the perfect choice.

At the emperor-elect's request, the Ethiopian Imperial Air Force, which consisted of two Junkers monoplanes, a Gipsy Moth, and two French pilots, performed a pre-coronation show. In an unplanned flourish, Julian leapt from Maillet's airplane, parachuting to the feet of Selassie, who was so pleased that he bestowed Ethiopian citizenship on Julian, the rank of colonel, and awarded him the Order of Menelik, the empire's highest honor.

Julian's glory was short-lived. Four months later, during a coronation dress rehearsal in Addis Ababa, Julian lost control of the de Havilland Gipsy Moth he was flying. As the emperor-elect looked on in fury, Julian made a crash landing into a eucalyptus tree. The Moth had been Selassie's personal airplane, a gift from Selfridge's department store in London, and Julian was expelled from the country amid allegations that he had stolen the aircraft. He accused the Ethiopian air force's French airmen of sabotaging him, but conceded in his 1964 memoir, *Black Eagle*, that "a crash at an air display watched by foreigners whom the Emperor wanted to impress was clearly a disaster."

So the Black Eagle returned to Harlem. For the rest of his life Julian would con-

tinue to promote himself as Selassie's air marshal, but Ethiopia would prove to be only a brief chapter in the Black Eagle's just-true-enough life story.

It was in Ethiopia, in 2001, that I first heard of Julian. I was visiting a family of Jamaican Rastafarians who had immigrated to Ethiopia, and while we were discussing the history of other West Indians who had settled in the country, Julian's name came up.

The Black Eagle is remembered in Ethiopia for his famous pre-coronation crash, and for his vocal anti-fascist stance in the days preceding World War II. He was spoken of reverently—although some of the details of his life were a bit muddled—and is remembered as someone who tried to do heroic things. Even though he didn't always succeed, he's considered a hero for trying.

In Julian's autobiography, I learned that he himself muddled some of the details of his life. He was born in 1897 in the British colony of Trinidad, the son of a cocoa plantation manager. He writes that he grew up in a middle class neighborhood in the capital, Port of Spain, where he attended a British-administered boys' school. The island's first exposure to flight ended badly: In January 1913, aircraft designer Frank Boland

The truth behind the tall tales of Hubert Fauntleroy Julian. by David Shaftel

crashed a tail-less biplane over the Queen's Park Savannah, near Julian's home, and was killed instantly. Julian, feeling the need to make the crash part of his personal narrative, moved it back to 1909 in his autobiography, placing himself at the scene.

I would learn that this compulsion to embellish was an essential part of Julian's



COLLECTION OF DOREEN JULIAN

Hubert Julian (opposite) hoped to enter a 1934 London-to-Melbourne race, but an airplane defect defeated his plans. Above: A world traveler, the dapper Julian founded Black Eagle Airline in 1946 to ferry goods between North and South America.



In the 1930s, Julian's rival, John Robinson (at far right), founded a pilots' association to promote aviation among African-Americans; he would later fly countless missions in Ethiopia, chased on occasion by the 140-airplane-strong Italian air force.

character. While these embellishments made it tempting to dismiss Julian as a charlatan, each time I dug deeper I found that his stories usually contained ample elements of truth.

So who was the Black Eagle? A serious aviator who was dismissed because of his race? Or a con artist, as some have suggested? Such blanket assessments miss the point: Julian was an adventurer in the classic sense of the word, a self-promoter who kept a toe in the waters of world history for half a century.

ALTHOUGH JULIAN HAD LEFT Trinidad by the time of Frank Boland's crash, news of the incident influenced him to patent, in 1921, the "Airplane Safety Appliance," essentially an amalgam of parachute and propeller. He later said his idea pre-figured the chutes used to return the Apollo spacecraft to Earth. Later that year, Julian moved to London to continue his studies, during which time he learned to speak French and Italian (he later added bits of Spanish, Swedish, Chinese, Urdu, and Finnish). In 1914 Julian moved to Montreal, where he claimed he was taught to fly by Canadian World War I ace Billy Bishop.

In 1921 Julian emigrated once again, this time to New York City, where he made a name for himself performing in aerial circuses. He also made a series of parachute jumps over Harlem—wearing a red "devil" jumpsuit during one, playing a

saxophone in another. After Julian buzzed a Negro Improvement Association meeting, Black Nationalist Marcus Garvey mistakenly informed the crowd that Julian was "the first Negro in America or in the British Isles or Commonwealth to qualify as a pilot," a claim Julian did not dispute. (We know that by 1930 he had flown in Ethiopia and the United States.) H. Allen Smith of the *New York Herald* dubbed him the Black Eagle of Harlem, a sobriquet he embraced till the end.

In 1924 Julian announced his intention to make a solo flight from New York to Liberia, by way of Atlantic City, New Jersey, and the West Indies, some three years before Charles Lindbergh's solo transatlantic flight. With the help of his frequent collaborator and financier, Clarence Chamberlin, Julian collected money in Harlem to buy a seaplane, which he christened the *Ethiopia I*. Chamberlin, who had tutored Julian in parachuting and was obsessed with record-setting flights, was himself a towering figure in the rarefied whites-only world of aviation, and would make the first transatlantic flight with a passenger in 1927. Julian writes that he had the support of the West Indian community, but was looked upon as a grifter by American blacks, an inter-community rift that Julian would again cite when he fell out with African-American aviator John Robinson in Ethiopia.

The transatlantic flight was doomed from the start, as Morris Markey recounted



in the *New Yorker*: "The ship left the water. One wing heavily down, it flew an astounding distance under the circumstances. For now it was revealed that the ship was indeed a rickety vehicle, and the pontoons were shuddering with the vibration. In fact, the Ethiopia I was still in sight when one pontoon came off entirely and the ship plunged toward the water. When it crashed it crashed hard." Julian was rescued by a machinist repairing a motorboat nearby, a man he upgraded to a rum-runner in his autobiography.

"AFRICA FOR AFRICANS" was the refrain in Harlem in 1935 as Ethiopia braced for invasion by Italy. Thousands of Harlem residents showed up to protest the invasion; Italian businesses were boycotted, and riots in Harlem marred boxer Joe Louis' victory over the Italian behemoth Primo Carnera at Yankee Stadium. Selassie's representatives put out a call for black doctors, nurses, engineers, and scientists in the United States to enlist in the defense of Ethiopia, but few African-Americans were able to do anything but donate small sums of money. As Harlem residents watched the events in Africa, Julian sailed again for Ethiopia.



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But the Black Eagle's plans were stymied by the presence of a foil, the "Brown Condor." Florida-born John Robinson's prowess as a pilot was unquestioned. With a diploma in auto mechanics from the Tuskegee Institute in Alabama and a certificate in aviation mechanics from the Curtiss-Wright Flying School, Robinson had been asked to head the civilian pilot training program at Tuskegee; he declined, accepting instead a position in the Ethiopian army. "Robinson was the real thing," said his biographer Thomas E. Simmons in an interview. "Without him, there would have been no Tuskegee Airmen. He's the man that planted the fire in the belly that got the flight school established."

Robinson flew countless reconnaissance and courier missions to the Ethiopian front—some accompanied by Selassie himself—in both an unarmed Beechcraft Staggerwing and a Potez, chased on occasion by fighters from the Italian air force, which, with 140 aircraft, outnumbered the tiny Ethiopian force. During his 12-month stretch in the country, he was shot in the arm during an aerial battle and exposed more than once to mustard gas. When Ethiopia fell, he fled only days before the emperor himself.



ASSOCIATED PRESS

When asked by the emperor to train an infantry detachment, Julian took to horseback. "I saw no reason why I should march when I could ride," he explained.

While Julian had been welcomed back into the emperor's good graces, he was not allowed near an airplane—so much the better, wrote Julian. "There were only twelve planes in the whole country," he said. "To have put them into the air in the path of the Italians would have been like throwing doves to hawks." Instead, Julian was consigned to drilling 3,000 barefoot citizen-soldiers, in whom he sought to instill "fire and the devil."

Antagonism between the two airmen finally came to a head when the Black Eagle and the Brown Condor encountered each other in a hotel lobby in Addis Ababa. Julian writes that Robinson was jealous of Julian's standing with the emperor and had been feeding lies about him to the press. "Robinson pulled a knife," wrote Julian, "so I picked up a chair, cracked him across the head with it and laid him out." Simmons tells a different story: "Julian came in there smarting off about Robinson, which was a mistake because John was a serious fellow with a short fuse, and he felt that Julian was undoing everything he was trying to accomplish."

The bulk of the injury was inflicted in the press, however, and Julian's days in Ethiopia were again numbered. In his memoir *Eye-witness*, Australian correspondent Noel Monks relates that Julian had already resorted to a side business. With correspondents virtually confined to their hotel rooms and dependent on official communiqués, they relied on

"'spies' and 'runners' whom we'd send off into the blue in search of war news," writes Monks. "Julian, the Black Eagle of Harlem was one of my 'spies'—and, I subsequently found, he was also 'spying' for half a dozen other newsmen. He had fallen from favour now, and was relying solely on the money we paid him."

When word of the dustup with Robinson reached the emperor, Julian fumed to Monks, "Can you beat it? This god-damned Emperor has put the finger on me. Says I've got forty-eight hours to get out of the country. Brother, no guy can do that to me and win a war." In December 1935, the Cunard liner *Aquitania* delivered Julian, dressed in beaver-hair coat and derby hat, back to New York. "Bah!" he told reporters. "I have come to the unanimous conclusion that Ethiopia does not need or deserve help."

With his return to the States, in May 1936, Robinson wrested the headlines from Julian. Robinson would return to Ethiopia in 1944, after the Italians were driven from the country, again to train Ethiopian fliers, but his time there was also not without humiliation. Robinson would be placed under house arrest for assaulting Swedish mercenary pilot Count Carl Gustav von Rosen, who was then working for Selassie. Von Rosen, Simmons says, told Robinson he would not be copilot to a black man. Robinson responded with a knockout punch.

James T. Campbell, professor of history at Stanford University, urges readers to put the experiences of Julian and Robinson into a broader historical context. "These are people whose horizons were bounded," he says. "They were never going to become American military pilots, they were never going to command the kind of prestige of Amelia



NASM (SI-99-15419)

After returning to the U.S. in 1930, Julian appeared in various airshows (above, in Los Angeles; right, in New York) and entered the movie business, producing potboilers like *Lying Lips* and *The Notorious Elinor Lee*.

Earhart or Charles Lindbergh, and they were never going to become the darlings of America, though they might become the darlings of black America. Ethiopia is a place where they could go and all of a sudden they are having dinner with the head of state. Or they are the head of an air force. The fact that people of this kind of distinction had to look outside of this country for some sense of identity and for the possibility of living lives of great achievement has something really powerful to tell us.”

AFTER HIS ETHIOPIAN days, things moved fast for the Black Eagle. He entered the movie business with Oscar Micheaux, the African-American filmmaker, and continued display flying, but as world war again loomed, Julian sought involvement. He famously challenged Reichsmarshal Hermann Göring to a dogfight over the English Channel to avenge Germany’s “cowardly insult to the honor of my race,” but the closest the Black Eagle got to active service was a stint in the Finnish air force during the 1939 Russian invasion of that country. The Finns gave Julian the rank of captain, but he saw no combat service, as the war in that theater had already ended. Julian, now 43, wrote that it was in Finland “that I was last at the controls of a plane.”

Julian’s second act began in earnest

when he established Black Eagle Associates, which started as a company that sold World War II military surplus but quickly evolved into an arms dealership. In fact, the seeds for the enterprise, according to the black newspaper *Chicago Defender*, had been sown during his second trip to Ethiopia, when he was reported to have escorted an arms shipment into the country, which was under a League of Nations arms embargo.

In 1949, Julian became a licensed arms dealer, acting as an agent for developing and newly independent nations. He became “richer now than a yacht full of Greeks.” He pursued this career with uncharacteristic discretion until 1952, when he would again find himself in the headlines after *Time* magazine reported that in three years as an arms buyer for the Guatemalan government, Julian had sold the left-leaning Jacobo Arbenz Guzmán regime “forty .50-caliber machine guns, six half-tracks, 3,000 pairs of boots, 20 bulletproof vests, and trucks, jeeps, rifles, bazookas and ammunition,” by way of Italy, Spain, and Switzerland, before relations between Guatemala and Julian soured and the shipments were suspended.

Those, and deals in the Dominican Republic, Haiti, and Pakistan, would earn him decades of FBI surveillance. The FBI’s file is typical of the era: obsessed with Communism and subtly racist, calling Ju-

lian “a playboy” who is “subsidized by wealthy white women.” The bureau also called Julian “a crook and imposter” and “arrogant,” but “very intelligent.”

By 1954, the book on Julian’s Ethiopian days was closed. While Julian was a globetrotting arms dealer living “high, wide, and handsome,” John Robinson died in Ethiopia after the airplane he was flying crashed near Addis Ababa in March. Two months later, in a show of solidarity with American blacks, Haile Selassie made a historic visit to Harlem, but this time the Black Eagle was not to be reunited with his former patron; his political allegiances inhabited murkier territory.

Julian was enjoying a second prime as a gunrunner, his time in Ethiopia now just part of his lore. His grandniece, Gail Cochran, 68, remembers visiting Julian in his Bronx townhouse on Sundays when she was a child, where he served exotic fruits and told her of his exploits in Ethiopia and elsewhere. The house, overlooking the Harlem River, she recalls as a museum of his life, with elephant tusks, ivory statues, vintage rifles, and a menagerie of tropical birds, two Persian cats named Ding and Dong, and at least one pet monkey. “He had 350 suits, which had to be made to order because he was so big,” she



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says. “He would go abroad at the drop of a hat, bringing back gallon bottles of perfume for my mother and sugar cane for me to eat, and gigantic oranges and thick, thick steaks. That was just his way.”

IT WASN'T UNTIL the early 1960s, during the Congo Crisis, that the Black Eagle's wings were finally clipped. Unable to resist the greatest mercenary gathering of Africa's post-colonial wars, Julian turned up in Elisabethville in the break-away province of Katanga, representing himself as an aid worker arranging for the passage of French-speaking doctors and nurses from the West Indies. On his third visit, Julian was arrested by United Nations law enforcement agents, he said, when he was found to be possessing three antique pistols he intended to give as a gift to his friend, Katangan leader Moise Tshombe, a firearms enthusiast. The U.N. accused him of serving as the middleman in an \$18 million arms shipment to Belgian-backed secessionists, this time in violation of a U.N. arms embargo. Simultaneously, four World War II-era B-26s linked to Julian and bound for Katanga were seized at Chicago and Newark airports. Julian, 65, spent four months in a Léopoldville prison before being repa-

Julian's less colorful activities were seldom covered by the press. In 1975 the Black Eagle (right) returned to Trinidad to donate funds to his old school's music program.



COLLECTION OF DOREEN JULIAN

triated to the United States. He denied involvement in arms dealing in the Congo to the last.

Upon his return to the United States, Julian continued to maintain his innocence in an interview with the FBI. “Julian was most emphatic in stating that he had never attempted to smuggle munitions into the Congo or arms of any sort, and added that if he wanted to, the United Nations officials in the Congo were so incompetent that it would be an easy matter for him,” the FBI report states. CIA correspondence from the era, however, reveals that at the time of his arrest, Julian possessed a purchase order from a Belgian dealer for 5,000 9-mm pistols, two million cartridges, 120- and 60-mm mortars and shells, and 3,200 machine guns.

The Congo adventure slowed the Black Eagle, but his FBI files reveal that he was connected with various African states, representing himself as a munitions buyer as late as 1974. After that the Black Eagle lost his rudder. In early 1976 Julian was investigated for threatening to hire “mercenaries utilizing seaplanes with 20 millimeter cannons and incendiary bombs” to sink the oceanliner *Queen Elizabeth II*; he alleged that Cunard employees had mistreated him. The investigation was dropped after Julian said he made the threat in a time of despair, shortly after the death of his wife Essie. The FBI's report on the incident, however, revealed that Julian had also been recently investigated for the intended purchase of 66 F-104 fighters from the West German government, again in violation of neutrality acts, and by the U.S. Customs department for the smuggling of gold and diamonds.

After these misadventures, Julian stopped courting the press and gave away most of his worldly treasures to the visitors and friends who still called on him.

The Black Eagle of Harlem died of natural causes at age 86 on February 19, 1983. His death went unnoticed in the press until eight months later, when the *New York Amsterdam News* printed an item in its gossip column that read: “The reason that Colonel Hubert Julian's death was unknown...boils down to this: His young wife didn't like his Black Eagle reputation and when he died...she reportedly phoned the...funeral home and told them to pick up the body and bury him, but fast.”

When I showed her the newspaper clipping, which she had never before seen, Doreen Julian, now 70, was incredulous. “I had nothing to do with this,” she said, at the home she once shared with Julian. “He didn't want any reporters swarming the house. He just told me to keep it peaceful, he'd had enough of it all.” Julian met Doreen in a hotel in her native Grenada on one of his frequent trips to his beloved West Indies, where he was impressed with her prowess ironing his custom-made shirts. Within a week he had brought her back to the United States. They were married in 1977, and she recalls caring for Julian “like a baby” until the end. “He didn't leave the house for the last five years,” she says. “There was nothing left to do, nowhere left to go. But he felt very comfortable with his life, and always talked all the time about the things he had done, the people that he had met, and all the money he used to make. He gave you so many stories you didn't know how to keep up with it all. His life was like a fairy tale.” —

PRESENT *at* CREATION

FROM FIVE WITNESSES CAME A FAMILY TRADITION TO HONOR
THE MOMENT THE AIRPLANE WAS BORN.

AT 10:35 A.M. EVERY DECEMBER 17, a small group of men, women, and children, usually bundled up against the winter winds of the Outer Banks, leave the warmth of the visitor center at the Wright Brothers National Memorial in Kill Devil Hills, North Carolina, to walk a short distance to the foot of a granite boulder. There they lay wreaths to mark the spot where Orville Wright left the ground on the first powered, controlled, heavier-than-air flight. They are a select group, the descendants of the four men and a boy who witnessed that historic event at this moment on this day so many years ago.

The annual wreath laying began on December 17, 1928, the 25th anniversary of the first flights. That year, 3,000 people traveled by boat, automobile, pony cart, and on foot to reach the birthplace of the airplane. The first commemoration was the work of the Kill Devil Hills Memorial Association, a group of locals who donated the land where the federal government would soon begin work on a great monument to the Wrights. The group also fought for a bridge that would link this remote section of the Outer Banks to the mainland, and a paved road to carry sightseers to the place where the air age began.

by *Tom Crouch*

Over the years, the association evolved into today's First Flight Society, which still organizes the annual commemoration. The current president, Bill Harris, served as superintendent of the Cape Hatteras National Seashore, which includes the Wright Brothers National Memorial, before retiring from the National Park Service. Harris has his own personal connection to the Wright story. On September 13, 1900, when Wilbur Wright first came ashore at Kitty Hawk after a harrowing voyage across Albemarle Sound in an open boat, the first person he met was 13-year-old Elijah Baum, who was out crabbing along the shore. The young man was kind enough to escort the visitor to the home

of William Tate, where the newcomer would be staying. Bill Harris, the grandson of that young Good Samaritan, maintains a quiet pride in Baum's small role in the Wright story. "My granddad's warm welcome and offer of assistance," he notes, "was only the first example of the friendship and hospitality which the residents of Kitty Hawk would extend to these visitors from faraway Dayton."

A good many of the other descendants who lay wreaths on the spot each year are also active in the First Flight Society (anyone wishing to help continue the tradition can join at www.firstflight.org). Lois Smith is the granddaughter of witness John T. Daniels, who took what may be the most famous photograph of all time: the image of the Wright *Flyer* just lifting off the launch rail with Orville Wright at the controls and Wilbur running alongside. After the

Jimmy Doolittle (at far left) was on hand in 1945, as Lois Smith laid a wreath at the site where her grandfather saw flight begin.

fourth flight of the morning, the brothers asked Daniels to remain outside minding the airplane while the others went into the shed to warm their hands. A gust of wind sent the world's first airplane tumbling backward with the faithful Daniels hanging on. In later years he would remind listeners that he had not only witnessed the first flight of an airplane, and taken the first picture of that event, but had also been the first victim of an airplane accident—all in one morning.

Daniels accompanied granddaughter Lois when she laid her first wreath here as a young girl in 1945. "He was," she remembers, "the sweetest man you can imagine." Lois cherishes photos of herself with her grandfather and aviation luminaries like Jimmy Doolittle and Igor Sikorsky, who made the pilgrimage to the Kill Devil Hills over the years and were delighted to meet the witness who photographed that historic moment. Lois says that her memories of her grandfather make her determined to continue the family tradition.

Johnny Moore, the youngest of the wit-



NATIONAL PARK SERVICE, WRIGHT BROTHERS NATIONAL MEMORIAL



LIBRARY OF CONGRESS

nesses, took his granddaughter, Karen Brickhouse, to her first commemoration in 1947. In 1903, Moore was living with his mother, a local “wise woman” who earned her living supplying natural remedies and telling fortunes. Having watched the brothers fly that morning, the young man went tearing down the beach toward Kitty Hawk, four miles to the north, shouting the news as he went. For Karen, attending the annual ceremony is a way of honoring her grandfather. “I promised my mother I would always represent us,” she explains, “and my kids have promised me that they will carry it on.”

Terry Beacham usually attends the December 17 ceremony dressed in the uniform of a turn-of-the-century member of the U.S. Lifesaving Service. A retired Coast Guard aviator, Beacham is not one of the wreath layers. At the time of the first flight, his grandfather, William Thomas “Tom” Beacham, was on duty at the Kill Devil Hills Lifesaving Station less than a mile away. He was there, however, when Wilbur Wright made an attempt at a

powered flight on December 14.

Terry adds a new detail to our knowledge of events leading to that failed first try. He shows me a familiar photo taken by Orville Wright on the morning of December 14 and points to a man, a boy, and a dog standing just behind the world’s first airplane as it rests on the sand. Those individuals, he explains, are his grandfather Tom, his father John, then age five, and John’s dog Bounce. For me, as a Wright biographer, learning the dog’s name breathes new life into that morning’s events.

John Beacham always remembered the candy that Orville kept in his pockets for the boys who hung around the camp, Terry recounts. When the Wrights fired up the engine on December 14, John and Bounce scampered off to escape the clatter and the flying sand. That day, the Wrights had laid the launch rail down the lower slope of the big dune. The weight of the machine headed downhill prevented Wilbur from releasing the line that restrained it. When the Lifesavers assisting that morning pushed the airplane up the

track a bit to relieve the pressure, Wilbur and the craft shot into the air, the airplane nosing up so sharply that it stalled. Wilbur made a hard landing only 60 feet from the takeoff point, damaging the front elevator support. Young John Beacham never forgot that aborted flight. Decades later, when Terry Beacham told his father that he wanted to become a Coast Guard aviator, the old man commented: “I didn’t know we had any insanity in the family.”

I’ll be on hand for the ceremony again this year. Last time I was invited to join in, by laying a wreath sent by the city of Dayton, the hometown I share with the Wright brothers. It will be good to see my old friends again, the descendants of the original witnesses. I look forward to watching one of them urge a child or grandchild forward to take up the tradition and lay the family wreath for the first time. —

Among the locals helping the Wrights were Tom Beacham (second from right) with young son John and his dog Bounce.

Sightings

PICTURES WORTH A SECOND LOOK

THE ONLY THREE Grumman F7F Tigercats flying in late summer 2008 lined up for this shot above Pyramid Lake, Nevada, on September 10, the first three-Tigercat formation flown since the 1960s. Unlike Grumman's other prop-driven, thick-neck felines—the Wildcat, Hellcat, and Bearcat—the Tigercat was built for speed. The Navy's first twin-engine fighter, it shouldered a pair of Pratt & Whitney 2,100-horsepower engines on a sleek body, and topped 450 mph. Too heavy for carriers, it flew from bases, mostly with the Marines. And too late for World War II, it saw time in Korea flying reconnaissance and radar bombing, and escorting B-29s on night raids.

The idea of herding the 'cats dawned on photographer David Leininger last summer at the Experimental Aircraft Association's fly-in at Oshkosh, Wisconsin. John Muszala, pilot of *Bad Kitty* (foreground), owned by Seattle's Historic Flight Foundation, told Leininger that he'd be at the Reno National Championship Air Races in September, where Mike Brown would be racing his own Tigercat, *Big Bossman* (middle). Then Clay Lacy showed up in a Tigercat owned by Joe Clark of Seattle.

For the photo shoot, the trio maintained 172 mph to keep from passing Leininger, in a Beechcraft Bonanza A36. "The airplane's not real responsive at such a low speed," says Lacy. "I looked over and saw Mike had about 15 percent flaps and I said, 'Heck, I'll do that too.'" Afterward, they wowed the crowd at Reno with a flyby.

"The growling of those engines running in unison," says Leininger, "it was a symphony of radial noise."

Five other Tigercats are on display around the country: at the National Museum of Naval Aviation in Pensacola, Florida; the Fantasy of Flight Museum in Polk City, Florida; the Pima Air & Space Museum in Tucson, Arizona; the Palm Springs Air Museum in California; and the Planes of Fame Air Museum in Chino, California.





Then & Now

FROZEN MOMENTS AS TIME MARCHES ON

Less Haste, More Flying

TRADING IN A JET for a propeller airplane might seem to some a step backward. But after a quarter-century of flying the Dassault Falcon HU-25 Guardian on sea patrols, the U.S. Coast Guard is exchanging its jet fleet for a turboprop, built by EADS CASA of Spain: the HC-144A Ocean Sentry.

According to Coast Guard officials, what the Ocean Sentry lacks in speed (276 mph tops versus 650 for the Guardian) and altitude (30,000 feet versus 42,000), it makes up for in endurance, lower operating costs, and superior sensors.

"This is the perfect platform," says Ron McIntire, Coast Guard project manager for the Ocean Sentry. "If we'd had a couple of these things during Hurricane Katrina, we'd have been a lot better off." The airplane far eclipses the sensor capabilities of the Guardian; the Ocean Sentry's equipment options include direction-finding gear that can pinpoint a signal 125 miles out, surface search radar, and an electro-optical infrared surveillance system.

The sensor package also has multiple communications channels, and allows the crew to receive and

send classified data to other aircraft, ships, and stations on shore.

pounds), the Ocean Sentry burns it at half the rate. With significantly easier maintenance, the Ocean Sentry's per-hour operating cost comes to less than \$1,000, compared to the Guardian's \$1,500 to \$1,800. A hydraulic-operated

Guard's air station in Mobile, Alabama. The Coast Guard now has five of the \$34 million Ocean Sentries. Plans call for a total of 36 by 2020, when the last of the 21 Guardians will be retired. The swap-out is part of the \$24 billion,

The Coast Guard's new Ocean Sentry can stay aloft for eight to nine hours, compared to the Guardian's four, and burns fuel at half the rate of the old jet.

send classified data to other aircraft, ships, and stations on shore.

Also important is the Ocean Sentry's ability to loiter; it can stay aloft for eight to nine hours, compared to the Guardian's four. Though both carry about the same amount of fuel (10,000

rear ramp also allows the Ocean Sentry to deliver bigger cargo and more troops, and a belly bubble window lets the crew do something not possible on the Guardian: look below the aircraft.

The window proved its worth last February, when crewmen on an Ocean Sentry training mission (without the sensor package) used it to spot an F-15C pilot whose fighter had collided with another F-15C over the Gulf of Mexico. The crew radioed the pilot's location and directed his rescue. (The other pilot had been killed.)

"I thought the window was geeky at first, but those things are amazing, one of the best features," says Lieutenant Commander Christopher Buckridge, who trains HC-144A pilots at the Coast

The slower but more sophisticated HC-144A (top) is replacing the HU-25.

25-year Deepwater program to upgrade the Coast Guard's ships and airplanes.

The old jet, which entered service in 1983, "is near and dear to my heart," says Buckridge, who has flown the Guardian for 15 years. "You can get on scene very quickly, report back, and the planners could have time on their side and be more proactive." With the Ocean Sentry, he says, "at first, I couldn't get over the fact that it was so slow. We're going slower in this aircraft but we have much better situational awareness. It is fun to fly."

PAUL HOVERSTEN





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— JAMES T. FENT, Gemologist*

Huge Ruby Found on Bali—Is It Yours?

Paradise is reflected in this magnificent 22 1/2 carat ruby...but the price is the most heavenly.

On the tropical island of Bali, the air is filled with ancient mystery and perpetual festivity. Who would have thought that our deep sea diving trip to this romantic paradise would lead us to a treasure of giant deep red rubies. This beautiful isle is so vivid and untouched it has become the spiritual inspiration for many an artist. Bali has gardens tripping down hillsides like giant steps, volcanoes soaring up through the clouds, long white sandy beaches, and friendly artisans who have a long history of masterful jewelry designs.

We stumbled upon a cache of giant natural rubies at a local artisan's workshop. He brought these exotic Burmese Rubies to Bali and now we have brought them home to you. Our necklace showcases a genuine **22 1/2 carat** facet cut ruby set in a frame of .925 sterling silver in the Balinese style. *That's right—22 1/2 carats!*

The ruby, raised above the hand-crafted Balinese silver detailing is surrounded by a bezel of sterling silver

and then wrapped with a twisted rope. The Oval Ruby Pendant measures approximately 1 1/4" by 1 1/2." This exotic pendant suspends from an 18" silver snake chain and secures with a spring ring clasp. Drape this pendant around your neck for a bold luxurious look. And, since rubies are rarer than diamonds, we hope your rings don't get jealous. Most likely, this will be the largest precious gemstone that you will ever own.



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Reviews & Previews

BOOKS, MOVIES, CDS, STUFF TO BUY

Picture Show

Through photographs and artwork, a new book documents the bold rise of the U.S. Air Force.

Air Force: An Illustrated History

by Chester G. Hearn. Zenith Press, 2008. 192 pp., \$29.95.

AN ATTRACTIVE coffee-table book, *Air Force: An Illustrated History* would make a nice gift for someone with a general interest in air crews and air power. The book starts in 1783 with balloons, takes us through the world wars to the Air Force's emergence as an independent service in 1947, and continues to the Air Force of today. Sidebars give us biographies of figures ranging from World War I air ace Eddie Rickenbacker to just-fired chief of staff General T. Michael Moseley.

Credited to a single author, *Air Force* sometimes reads like a committee wrote it, with some portions sharper than others. A chapter about B-29 Superfortress operations against Japan is crisp and informative. On the other hand, a segment about the Air Force emblem refers to the famous "Hap Arnold emblem" of World War II, but the accompanying illustration shows the newer service logo introduced in 1997.

The book is not without



the occasional error: The P-38 Lightning raid that killed Japan's Admiral Isoroku Yamamoto was led by Major John Mitchell, not Captain Thomas Lanphier. And a

photograph identified as a low-flying F-86 Sabre firing air-to-ground rockets at "Red Chinese positions" in

Korea in 1950 actually depicts a high-flying F-86D Sabre (it has an Air Training Command badge on its tail) firing air-to-air rockets in Texas in 1955.

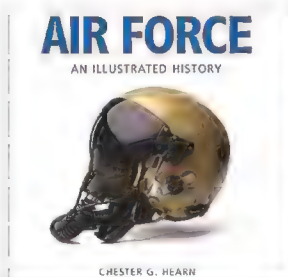
In June 1944, P-38s attacked targets in German-occupied France (above). A World War I recruiting poster (right).

The mix of color and black-and-white illustrations and photographs includes many fine choices, though some of them are widely published, public-domain images. Still, the book is a good guide for someone who perhaps has a family member in the Air Force and wishes to learn more about this branch of the military.

ROBERT F. DORR IS CO-AUTHOR OF *HELL HAWKS*, A



HISTORY OF AN AMERICAN FIGHTER GROUP IN EUROPE IN THE FINAL YEAR OF WORLD WAR II, WRITTEN WITH THOMAS D. JONES. DORR IS AN AIR FORCE VETERAN, A RETIRED U.S. DIPLOMAT, AND AN AUTHOR. HE WRITES A WEEKLY COLUMN FOR *AIR FORCE TIMES*.



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Homesteading Space: The Skylab Story

by David Hitt, Owen Garriott, and Joe Kerwin.
University of Nebraska Press, 2008. 548 pp.,
\$29.95.

BOOKS BY ASTRONAUTS are sometimes entertaining, sometimes insightful and reflective, sometimes revealing, and sometimes inspiring. A very few accomplish all of these goals. The gold standard is *Carrying the Fire* by Apollo 11 astronaut Michael Collins. While *Homesteading Space* is not as thoughtful and perceptive as Collins' memoir, it is a worthy account of an important but largely forgotten program.

With the help of journalist David Hitt, *Homesteading Space* tells the story of the Skylab orbital workshop, the first U.S. space station (see excerpt from another book about Skylab, right). Launched in 1973, it was occupied through early 1974 by three crews of astronauts, including co-authors Owen Garriott, Joe Kerwin, and Alan L. Bean (Bean's flight diary is published in the book).

Skylab was launched into orbit on May 14; it was the last use of the giant Saturn V vehicle. Almost



immediately, vibrations during liftoff caused problems, and the first crew to fly, astronauts Pete Conrad, Paul J. Weitz,

and Kerwin, had to resolve them and make the space station operational. That crew returned to Earth on June 22, and two other crews followed, one with Garriott, the other with Bean.

The three crews occupied Skylab for a combined total of 171 days and 13 hours. During that time, they conducted nearly 300 scientific and

technical experiments. Perhaps more important, Skylab was the United States' first real test of long-duration spaceflight. (On the last mission, the harried crew staged a one-day strike against mission control.)

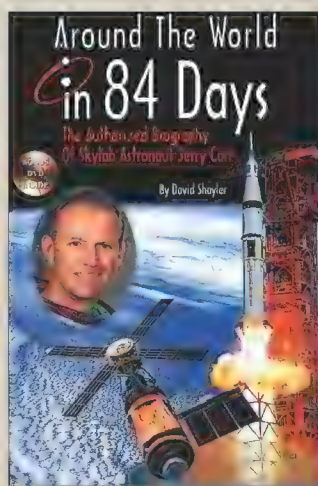
For those who would like to learn more about the achievement,

>>> Excerpt <<<

ASTRONAUT JERRY CARR was the commander of Skylab 4, from November 16, 1973, to February 8, 1974. This excerpt of his biography is from a chapter titled "Christmas in Space," which includes portions of a diary Carr kept while in orbit.

Around the World in 84 Days: The Authorized Biography of Skylab Astronaut Jerry Carr

by David Shayler. Apogee Books, 2008. 272 pp., \$31.95.



MISSION DAY 35, DECEMBER 20: One more week and we're half way there. The last couple have gone pretty fast. Looks like all the exercise is paying off. I'm exercising more (and enjoying it less) now than I have since my freshman year at USC. All my fat has gone. I wonder how long it will take me to get it back when I get home. Just after dark tonight we flew east of Chicago, and looking north we saw the Aurora Borealis. What a beautiful but eerie sight. The whole northern part of the world seemed to have glowing fuzz growing up from it. Sitting up here looking at things like that sure makes you think differently about the Earth. You get used to your own little niche – your own surroundings

where you live – and you lose sight of the whole wondrous thing. It's so big, and there are so many desolate areas! There's so much water! Most of the world's population is crowded into a fairly small percentage of the surface. No wonder the population explosion is bothering the experts. There is all sorts of room to expand, but so little of it is viable. No one is going to volunteer to live out in the hinterland to make more room for those in the temperate areas. Christmas is coming fast. We should make it with our tree, and I hope we can pull together some meaningful remarks to make on Christmas Eve. I guess we'll try to do our own thing around mid-day so that we can get started on the EVA prep and get to bed at a reasonable hour.

MISSION DAY 39, DECEMBER 24: Today's been a unique day indeed. We started it off with our Christmas message. I wasn't sure that we had chosen the right tone. I guess it went pretty well. The guys on the ground said it was good. The Christmas greetings started coming in. First one's [from NASA administration] typically carefully worded, but it sure makes us feel good to receive all those good wishes. This afternoon we began the prep for EVA – it's always a frantic affair. There are so many things to haul out and pre-position. Tomorrow is my opportunity to get outside and look around. I'm really excited about it. What a way to spend Christmas Day! I can hardly wait to get out and stand up like a wing-walker and watch the world go by.

Homesteading Space offers valuable personal recollections from those who were there.

■ ■ ■ ROGER LAUNIUS IS A CURATOR AT THE NATIONAL AIR AND SPACE MUSEUM'S DIVISION OF SPACE HISTORY. HE IS THE CO-AUTHOR OF *ROBOTS IN SPACE*.

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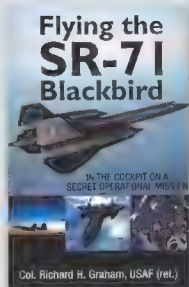
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>>> At a Glance <<<



Flying the SR-71 Blackbird: In the Cockpit on a Secret Operational Mission

by Colonel Richard H. Graham, USAF (ret.). Zenith Press, 2008. 288 pp., \$25.95.

Former Blackbird pilot Graham details an SR-71 mission, from donning a pressure suit to returning to base.

Aircraft Carriers: A History of Carrier Aviation and its Influence on World Events, 1946-2006

by Norman Polmar. Potomac Books, 2008. 548 pp., \$49.95.

The author delves into the role of aircraft carriers in controversies over strategic deterrence and the unification of the U.S. armed forces.



Through Blue Skies to Hell: America's "Bloody 100th" in the Air War Over Germany

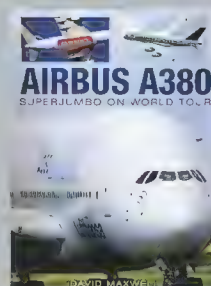
by Edward M. Sion. Casemate, 2008. 220 pp., \$32.95.

Through Blue Skies to Hell takes a close look at the air war over Europe during World War II.

Airbus A380: Superjumbo on World Tour

by David Maxwell. Zenith Press, 2007. 159 pp., \$29.95.

A coffee-table book documenting the A380 in all its behemoth glory.



Death From the Skies!: These Are the Ways the World Will End...

by Philip Plait. Viking, 2008. 324 pp., \$24.95.

Written in a humorous, conversational style, *Death From the Skies!* examines the likelihood of the calamities that threaten Earth, such as asteroid impacts and supernova detonations.

The Luftwaffe Over Germany: Defense of the Reich

by Donald Caldwell and Richard Muller. Greenhill Books, 2007. 336 pp., \$50.

World War II aviation buffs will appreciate this comprehensive analysis of German daylight air defense.



The Story of the Spitfire: An Operational and Combat History

by Ken Delve. Greenhill Books, 2007. 272 pp., \$39.95.

Drawing from archival material and firsthand accounts, this book offers a thorough account of a remarkable aircraft and its pilots.

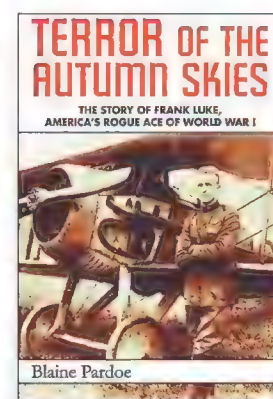
Terror of the Autumn Skies: The True Story of Frank Luke, America's Rogue Ace of World War I

by Blaine Pardoe. Skyhorse, 2008. 320 pp., \$24.95.

BEFORE FRANK LUKE, fighter pilots were thought to be steadfast combatants. After Luke, their image became bold and brash. Luke came from the last outpost of the Old West and flew into the sunset over France. During 17 days in the fall of 1918, he defied his superiors and the odds to become America's "Ace of Aces."

Gratingly full of himself, the 20-year-old found his niche in one of the American Expeditionary Force's Spad XIII's, downing feverishly defended German observation balloons—a low-altitude, lone-wolf specialty so frequently fatal and inglorious that even aces shunned the missions.

Author Blaine Pardoe recounts Luke's short life, from a free-spirited childhood in the Arizona Territory to his September shootdown-a-thon above the Hindenburg Line. The



choreography of those 18 conquests is described, often from both American and German viewpoints. In first-person voices resurrected

from combat logs and pilot diaries (further expanded in the book's chapter notes, which make compelling reading), August's bull-shooting ace wannabe morphs meteorically and tragically into October's posthumous Medal of Honor nominee.

Pardoe challenges long-accepted lore as methodically as Luke busted the Kaiser's balloons. The saga of Luke's last stand—shot down over a French village, decimating a squad of German infantry with a blazing Colt .45 before dying with finger on the trigger—

>>> **Excerpt** <<<

Airplanes: The Life Story of a Technology

by Jeremy R. Kinney. Johns Hopkins University Press, 2008. 160 pp., \$19.95.

ONE OF THE MAJOR aerodynamic challenges of the 1950s was bridging the gap between subsonic and supersonic speeds. Much was known about those regimes, but little was known about the regime in between, the transonic regime. The Air Force's new

YF-102 Delta Dagger delta wing fighter designed by Convair of San Diego, California, was unable to reach supersonic speeds during its first flights in 1952. A substantial Air Force contract and Convair's reputation were at stake. A mild-mannered NACA [National Advisory Committee for Aeronautics] researcher named Richard Whitcomb (1921-), who had been studying the problem of transonic drag, used a special tunnel at Langley. He realized that the increase in drag as an airplane approached supersonic speeds was not the result of shock waves forming at the nose, but by those forming just behind the wings. Whitcomb asserted that narrowing, or pinching, the fuselage where it met the wings would decrease transonic drag and NACA transonic wind tunnel research supported his idea. The improved YF-102A with its new area rule fuselage achieved supersonic flight during its first flight in 1953. Moreover, the area rule fuselage increased the Delta Dagger's top speed by 25 percent. Whitcomb's revolutionary idea enabled a new generation of military aircraft to achieve supersonic speeds.



Jeremy R. Kinney, a curator in the aeronautics department at the National Air and Space Museum, offers a well-researched and thorough account of aeronautic development from 1783 to today. This excerpt is from a chapter titled "The Second Aeronautical Revolution, 1930 - Present."

recurs everywhere, from postwar pulp magazines to Wikipedia entries. But the author painstakingly reconciles conflicting German and French eyewitness accounts, inviting the reader to consider a more probable, less Alamo-like scenario.

The image that emerges from Pardoe's meticulous research (400 cited sources) is a sharply focused one. Frank Luke wouldn't grasp much about the cockpit of a 21st century F-22 Raptor, but he'd almost certainly recognize the supremely confident, fiercely competitive pilots who occupy it as kindred spirits and his natural heirs.

■ ■ ■ STEPHEN JOINER IS A FREQUENT CONTRIBUTOR TO *AIR & SPACE/SMITHSONIAN*. HE WROTE "AIRLINER REPAIR, 24/7" (OCT./NOV. 2008).

Catalina by Air

by Jeannine L. Pedersen. Arcadia Publishing, 2008. 127 pp., \$19.99.

This charming collection of black-and-white photographs documents airline service to California's Santa Catalina Island during aviation's Golden Age. Even non-aviation buffs will smile at images of seaplanes – from gawky amphibians to sleek flying boats – making their way in and out of the picturesque harbor at Avalon Bay.

■ ■ ■ DIANE TEDESCHI IS AN ASSOCIATE EDITOR AT *AIR & SPACE*.



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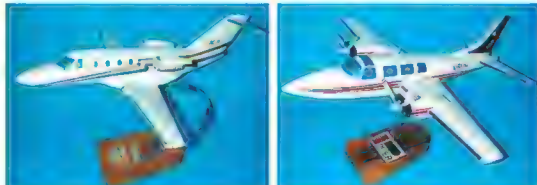
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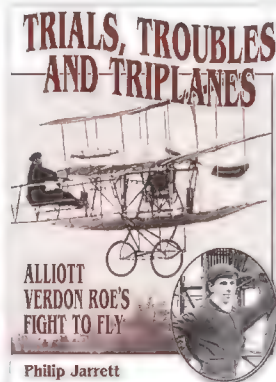
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Reviews & Previews

Trials, Troubles and Triplanes: Alliott Verdon Roe's Fight to Fly

by Philip Jarrett. Ad Hoc Publications, 2007.
128 pp., \$29.

ONE OF THE PERSISTENT, if low-key, controversies of early aviation history is the question of who made the first powered heavier-than-air flight in Great Britain. In his magisterial *The Aeroplane: A Historical Survey*, C.H. Gibbs-Smith argued that while "historians would not doubt" that Edwin Alliott Verdon Roe made "a few short hops" in a biplane at the Brooklands Race Course on June 8, 1908, credit for the first genuine powered airplane flight in Britain should go to the American S.F. Cowdery (aka Cody), who flew 1,390 feet at Farnborough on October 16, 1908. Still, partisans have never ceased arguing that the "first to fly" honors should be awarded to Roe, who was, after all, English and the founder of one of the world's great aviation manufacturing firms, Avro.



In this detailed and richly illustrated account of the early aviation career of A.V. Roe, Phil Jarrett puts the controversy to rest. In 2007, preparing for the upcoming centennial of British aviation, Jarrett took a look at a letter that Roe sent to Major B.F.S. Baden-Powell of the

Aeronautical Society of Great Britain—one often cited as evidence for a short hop on June 8. Jarrett was stunned to discover that, far from having left the ground, Roe had, in his own words, "nearly flown."

Broadening his investigation, the author found that the testimony of the few witnesses who claimed to have seen Roe fly on June 8 was full of holes. His conclusion: The first time A.V. Roe left the ground in powered flight, it was in another machine, and 13 months later.

This is a book for those who prefer history to legend, and who enjoy looking over an author's shoulder as

>>> Aviation Art <<<

Rocket Man

ON NOVEMBER 15, 1960, North American Aviation chief engineering test pilot Scott Crossfield, having been released from a Boeing B-52 at 40,000 feet, flew a rocket-powered X-15 to an altitude of 81,200 feet and a speed of Mach 2.97. Aviation artist William J. Reynolds rendered the flight in "On the Way to the Stars"; limited-edition prints, signed by Reynolds and Crossfield, are available for \$299, which includes shipping and handling. Proceeds from sales will go to the nonprofit Scott Crossfield Foundation, which supports aerospace education.

Prints can be ordered at
www.scottcrossfieldfoundation.org.



he unravels a mystery. Controversy aside, Jarrett has provided us with a solid account of the early years of a leading aviation pioneer, who, while not the first to fly in Britain, founded a company that would help shape

the history of the 20th century.

■ ■ ■ TOM CROUCH IS AN AERONAUTICS CURATOR AT THE NATIONAL AIR AND SPACE MUSEUM. THE AUTHOR OF SEVERAL BOOKS ABOUT EARLY FLIGHT, HE WROTE "PRESENT AT CREATION," ON P. 64.

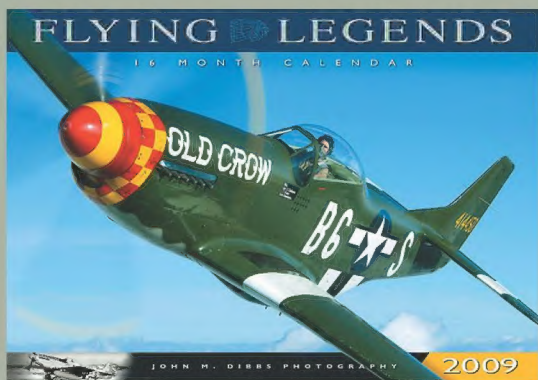
>>> Calendar Roundup <<<

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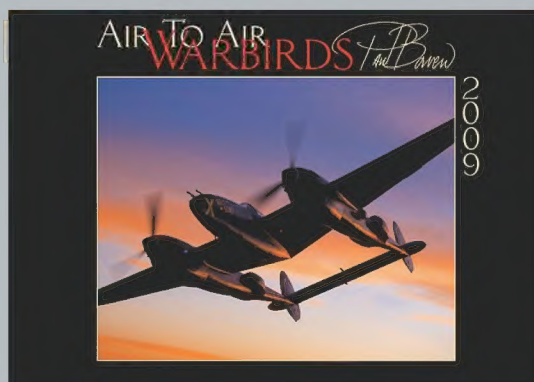
Ghosts: World War II and Ghosts: The Great War Photographs by Phil Makanna. \$14.95.



Flying Legends and Air Superiority Photographs by John Dibbs. \$14.95.



Air to Air: Warbirds Photographs by Paul Bowen. \$14.95.



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The second in a series on aircraft of the Vietnam War reports what it was like to thunder into North Vietnam in a Republic F-105.



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STARS LIKE SALLY RAND (at left) mingle with the subjects of family photos in the Air & Space Reader Scrapbook, which has grown to almost 400 images. Add yours today. **ALSO:** As a new president heads to the White House, we present the airplanes of past presidents in an Air Force One gallery. Finally, learn more about the rare airplanes that showed up at the 2008 antique aircraft fly-in (below).



A Ford Tri-motor (foreground) and a Waco ASO were among the visitors to Blakesburg, Iowa, in 2008. Top: From the Reader Scrapbook, Sally Rand and Waco, 1927.

Credits

Take a Left at Portugal. A former test pilot in the U.S. Air Force, Jim Jimenez is a career diplomat in the U.S. State Department.

A Christmas Story. Christopher Hope, a master flight instructor, is executive director of The Dictionary Project Kansas City.

Red & the Robots. Geoffrey Little writes frequently about space exploration.

Where Have All the Phantoms Gone? F-4 Phantom pilot Ralph Wetterhahn flew 180 combat missions. He is the author of *The Last Flight of Bomber 31*.

Welcome to Cyberairspace. Ed Regis, the author of seven books about science, has been writing for the magazine since 1991.

You've Got Mailplanes. John Fleischman says his latest nonfiction book for older kids, *Black and White Airmen*, "is about flying, World War II, segregation, and friendship. And it has a happy ending."

How Things Work: Ground Resonance. Peter Garrison is a frequent contributor to *Air & Space/Smithsonian*.

A Cameraman on Mars. Andrew Chaikin can be reached through his Web site, www.andrewchaikin.com.

One More Second. James R. Chiles is the author of *The God Machine: From Boomerangs to Black Hawks, the Story of the Helicopter*.

The Black Eagle of Harlem. David Shaftel is documenting the life of Hubert Julian and welcomes information and recollections at davidshaftel@gmail.com.

Present at Creation. Tom Crouch, the senior aeronautics curator at the National Air and Space Museum, has published widely on the history of flight.

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Giddyup 409

WHEN JON SHARP and his air racing team flew the NemesisNXT kit airplane to a qualifying speed of 409 mph at the Reno Air Races last September, they not only became the first in the Super Sport category to break 400 mph, they also made hearts beat faster among light-airplane owners and pilots who fly behind the traditional horizontally opposed piston engines that have powered smaller aircraft for decades. That a conventional Lycoming engine—admittedly hand-built and tweaked to extract every last bit of horsepower—could hit speeds previously reserved for the Unlimited and Jet classes was like a hot shot of adrenaline for aviation buffs everywhere.

“We’ve known for a long time the plane would get there,” Sharp says. “We just needed to get the right combination of things going at the same time. We came close in 2007, but with just a few little tweaks and mods here and there, plus the pilot getting better in the plane....” When Sharp gets excited, which is most of the time, he sometimes doesn’t complete a sentence, but you know what he means.

Sharp attributes the airplane’s success partly to a design that focuses on one goal: achieving 400 mph. The first versions were designed around tandem seating until aerodynamics dictated that the fuselage outline follow the width of the engine until a point aft of the wing’s trailing edge. (The happy side effect: Sharp and wife Patricia, who recently donated a kidney to her husband, can hop into the side-by-side cabin with an overnight bag and fly home after a race.) With its elliptical leading edge,



the wing looks like the leading half of a Spitfire’s, and the raked wingtips are adapted from a NASA design Sharp calls a “sheared tip.”

For air-cooled engine installations like this one, engine cooling adjustments are mostly trial and error. The trick is to take 400-mph air into the engine room, slow it down so it can do its cooling thing, then move it out the exit as close to 400 mph as you can. “As we learned more about the plane, and what it wanted to go fast,” says Sharp, “we refined the ratios of all the inlets to the exit sides to help reduce the cooling drag a bit.”

Sharp says his partners at Lycoming provide the TIO-540-NXT engine with twin turbochargers and twin intercoolers. “They’re always doing little refinements, and they don’t always tell me what they’ve done,” Sharp says. “Sometimes that’s for the better, because you know pilots can’t keep a speed secret under their hat.” He knows Lycoming

As Nemesis rocketed past 400 mph, pilot Jon Sharp entered territory held by aircraft in the Unlimited and Jet classes.

worked on the anti-detonation injection (ADI) system, which squirts a 50-50 mix of water and methanol into the river of induction air downstream of the turbochargers. As it flash-evaporates, it absorbs heat from the air and softens the combustion within the cylinder, thereby “reducing” (Sharp won’t use the word “eliminating”) any tendency to pre-ignite and “turn the engine into a grenade,” in Sharp’s words. Lycoming rates the engine at 350 horsepower. To get to 409, it’s got to be producing well over 400 ponies, but Sharp winks and says everything runs to stock specs. So it’s difficult to describe the NemesisNXT as a “kit,” although that’s what it is. And the fact that anyone can go out to a garage and build one makes it all the more wonderful.

■ ■ ■ **GEORGE C. LARSON, MEMBER, NAA**

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